STUDIES ON SOME PARASITIC ASPECTS OF <u>RHIZOPUS SPECIES</u> CAUSING ROT AND PREMATURE FALLING OF FRUITS IN JACK-FRUIT PLANT

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BY

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1995

DEDICATED

TO

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This is to certify that the thesis entitled "*STUDIES ON SOME PARASITIC ASPECTS OF RHIZOPUS SPECIES CAUSING ROT AND PREMATURE FALLING OF FRUITS IN JACK-FRUIT PLANT*" imbodies the research work of Km. Vinita Vishwakarma, who worked under my guidance and supervision during the year 1993-1995 as a research fellow in this department for the degree of Doctor of Philosophy (in Botany) of Bundelkhand University, Jhansi (U.P.). The thesis has not been submitted for any degree to any other university.

Dated :-

M. Z. Siddiqui

(Dr. M. Z. SIDDIQUI)

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Km. VINITA VISHWAKARMA

INTRODUCTION

AND REVIEW OF

LITERATURE

Plate No. 1 :- A Jack fruit tree
(Artocarpus heterophyllus Lamk.)
showing healthy fruits.

India, a country of 92 crore population is basically a agricultural country and almost eighty percent people of our country are farmers, besides cereal crops huge quantity of fruits and vegetables are grown by them. Some of these fruits and vegetables are also exported to other countries. The quality and quantity of these agricultural products are very important. The main damage to these products is caused by plant diseases. It is therefore very important, to protect these products from plant pathogens in fields, transit and storage.

Soft-rot is one of the major causes of losses in finance, Patil & Pathak (1993). In our country favourable conditions of temperature, humidity and suitable substrate in the form of fruits and vegetables are readily available for growth of these pathogens. The soft-rot pathogens not only damage the host tissue and lowers their nutritional value but also make them unfit for use.

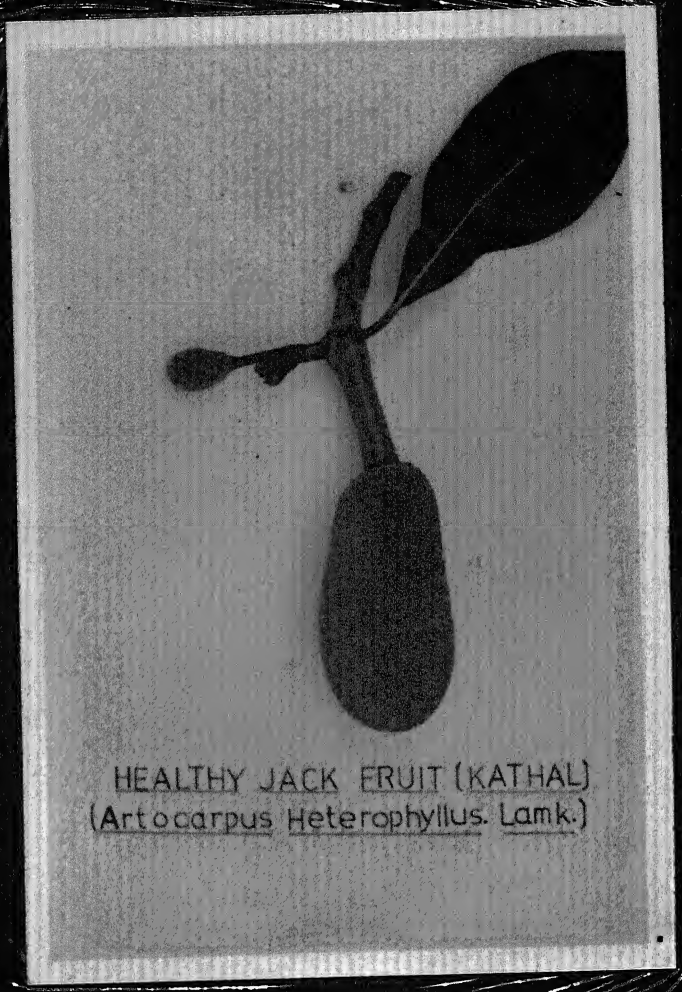
Among the fungal pathogens responsible for causing soft rots in fruits and vegetables, different species of Rhizopus play an important role, Harter and Weimer (1922); Mehta (1937); Mehta (1939); Das Gupta and Bhatt (1946); Ramsey, Wiant and Mc-Collach (1953); Bhargava (1957);

Plate No. 1 :- A Jack fruit tree
(Artocarpus heterophyllus Lamk.)
showing healthy fruits.


JACK FRUIT

Plate No. 2 :- A healthy Jack-fruit-kathal

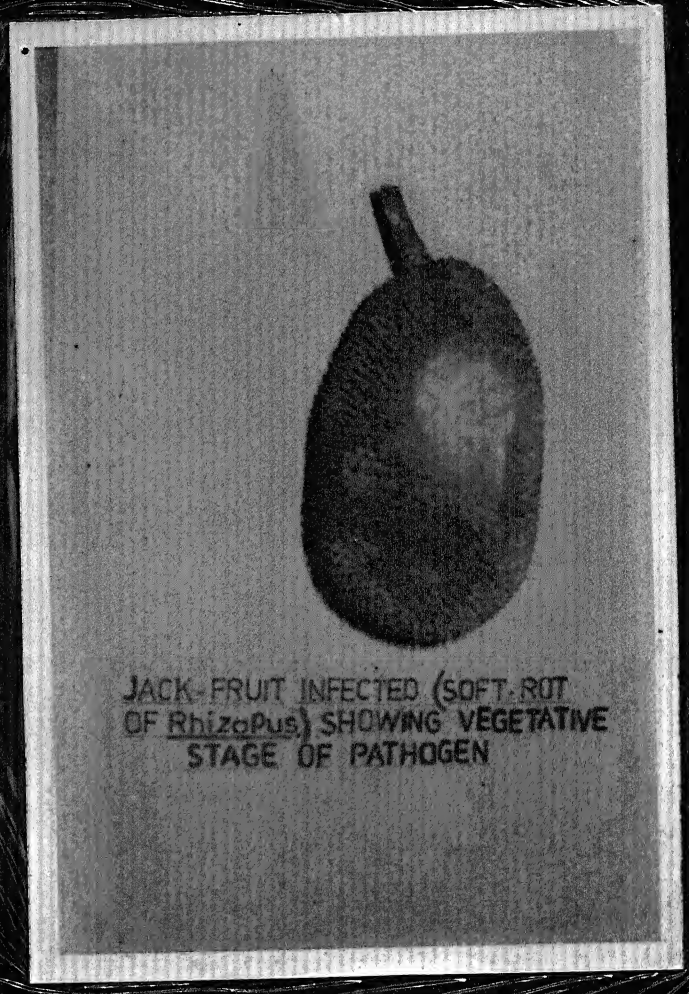
(Artocarpus heterophyllus Lamk.)



HEALTHY JACK FRUIT (KATHAL)
(Artocarpus Heterophyllus. Lamk.)

te No. 3 :- Jack-fruit (Artocarpus heterophyllus Lamk.) infected with soft-rot of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind., showing vegetative stage of the pathogen.

Plate No. 3 :- Jack-fruit (Artocarpus heterophyllus Lamk.) infected with soft-rot of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind., showing vegetative stage of the pathogen.



JACK-FRUIT INFECTED (SOFT-ROT OF *Rhizopus*) SHOWING VEGETATIVE STAGE OF PATHOGEN

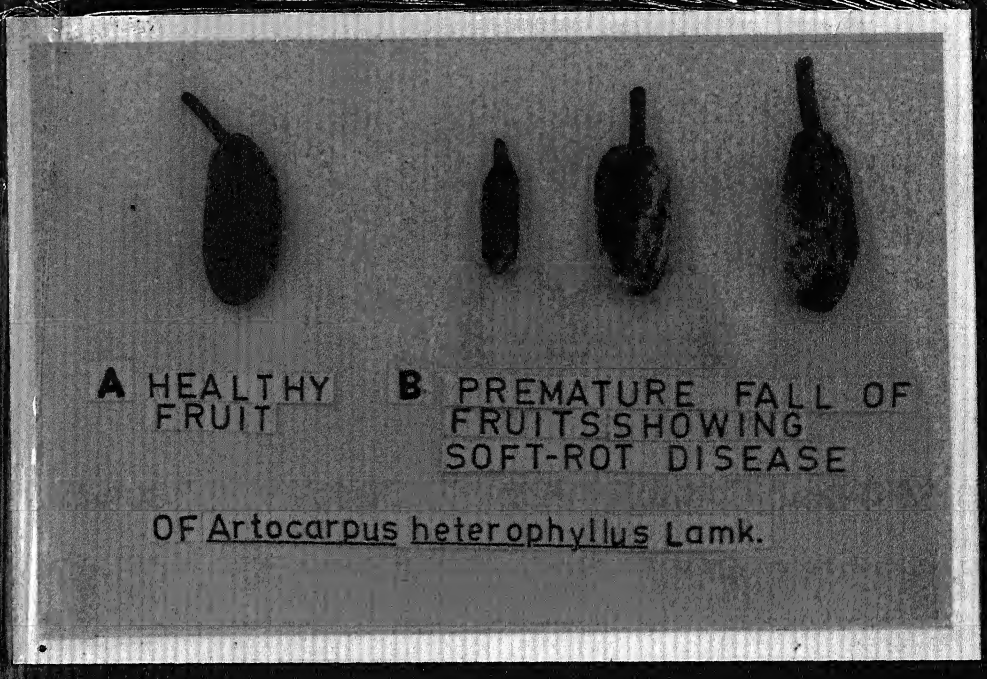
Solanum melongena L. (brinjal) and 8.15% for some cucurbits (Chaudhary, 1968; Chenulu & Thakur 1968).

Prasad et.al., (1989) reported that severe rotting occured in potato tubers and total losses averaging 24.64%, due to Rhizopus arrhizus. Rokade (1991); Mehrotra et.al., (1991); Patel & Patel (1991); Kurucheve et.al., (1991) also reported soft-rot of fruits and vegetables caused by different pathogens. Kusum Badyal (1991) reported soft-rots of almond and walnut caused by Rhizopus stolonifer and Rhizopus oryzae and post harvest fungal rots of sweet Cherry (Prunus avium Linn.) fruits. Akano & Oso (1991) reported onion infection caused by Rhizopus microsporus led to complete degradation of host tissue cell walls.

The jack-fruits (Artocarpus heterophyllus Lamk.) a important fruit vegetable and also called kathal of family moraceae, is grown world wide for its food value, Morton (1965); Ochse et.al (1981); The jack-fruit is an important source of pectin, Krishnamurthi and Giri (1949); & Vilasachandran et.al., (1985). The crop is grown in both north and south of our country, Singh (1969). As regards the quantum of yield per unit area jack-fuit occupies almost the first position among south indian fruits, Sadasivam and Neelakantan, (1975). The area under cultivation (8,000 ha. in

Plate No. 4 (a) :- Premature fall of Jack-fruits (Artocarpus heterophyllus Lamk.) showing soft-rot disease caused by Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. compared with a healthy fruit.

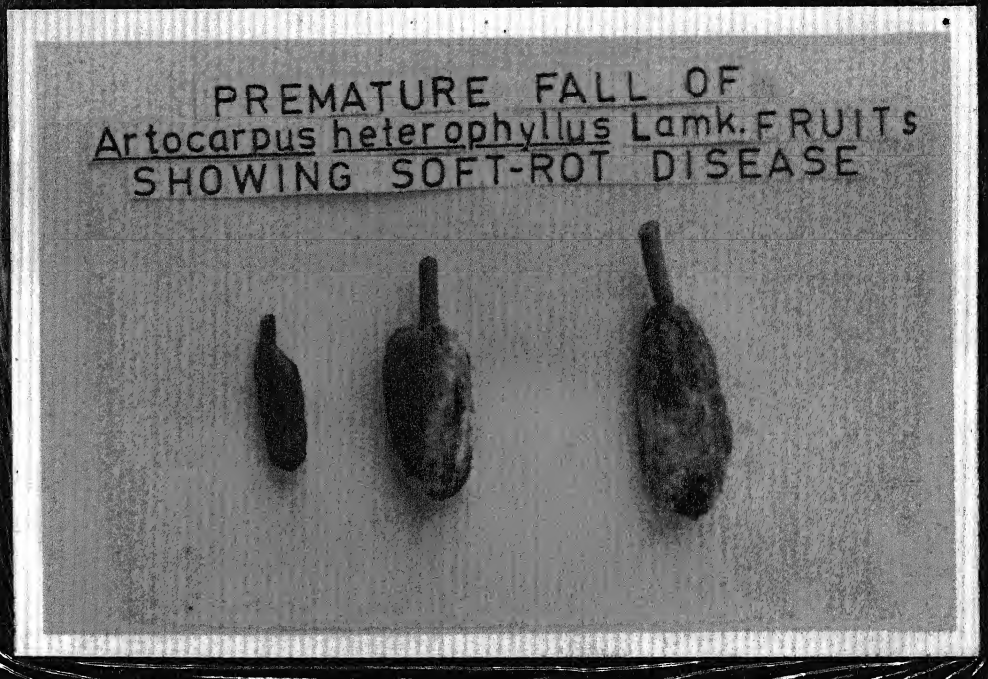
Plate No. 4(b) :- Premature fall of jack-fruits (Artocarpus heterophyllus Lamk.) showing soft-rot disease of R. stolonifer.



A HEALTHY FRUIT

B PREMATURE FALL OF FRUITS SHOWING SOFT-ROT DISEASE

OF Artocarpus heterophyllus Lamk.



PREMATURE FALL OF
Artocarpus heterophyllus Lamk. FRUITS
SHOWING SOFT-ROT DISEASE

Assam; 4,000 ha. in Bihar and 12,000 ha. in South India). Jack-fruits is available in the market during the month of March to July. The fruit has high nutritive value as it contains important ingradients; glucose, fructose, xylose, rhamnose, arabinose, lactose, galacturonic acid and some other sugar and protein, Hussain et. al. (1979); Zaghlol et.al.,(1983); Berry & Kalra (1987). The latex of the fruits posses bacteriocidal-properties, Fernando et.al., (1991). The water soluble hot water extracts of fruits is useful for diabetic patient.

Soft-rot and falling of premature jack-fruits caused by different species of Rhizopus is responsible for causing most serious damage of this fruit vegetable; Mitter & Tandon (1930); Bisby et.al., (1933); Chaudhary (1949), Patel et.al., (1949) and Roy (1981) . The losses in jack-fruit crop due to soft-rots ranging from 35 to 80 percent have been reported, Pandey et.al., (1979); Roy (1981); Roy (1983) and Singh & Singh (1989).

It is evident from the above that jack-fruit is one of the important fruit vegetable and as such must be protected from the plant pathogens specially from the premature falling of fruits and rots caused by different species of Rhizpous.

Plate No. 5 :- Premature Jack-fruits (Artocarpus heterophyllus Lamk.) infected with soft-rot of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. showing vegetative and reproductive stage of the pathogen.

INFECTED JACK FRUIT WITH
SOFT ROT SHOWING VEGETATIVE
AND REPRODUCTIVE STAGE OF Rhizopus.

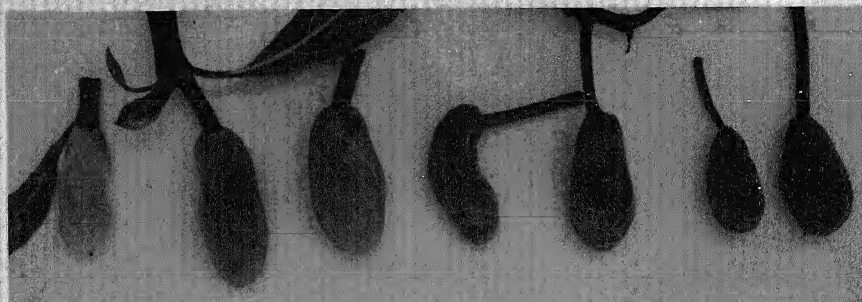
The Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. causing soft-rots disease produces its symptoms in the form of premature falling of jack-fruits. The pathogen attacks the male inflorescence and young fruits. The rots usually initiates near the stalk end which is latter covered by mycelium of the fungus. Quickly the whole fruits gets rotten and eventually drops off. Disease is most severe at. 30 °C temperature. The disease fruits are differentiated from healthy fruits by change of taste, odour and colour.

During the field survey of jack-fruit plants in Bundelkhand region viz., Tikamgarh (M.P.); Baruasagar; Narayan Bagh and C.P. Mission Compound areas of Jhansi (U.P.). It was found that the premature falling of jack-fruits caused by Rhizopus stolonifer (Ehrenb. ex.Fr.) Lind. is main disease of this plant and is responsible for most severe damage to this crop.

Some important work has been carried out on the taxonomy and morphology of the Rhizopus species by Fischer (1892); Lendner (1908); Hanzawa (1912-1914); Hutchinson and Ram Ayyar (1915); Saxtur (1920); Thakur and Norris (1928); Yamamoto (1930); Yamazaki (1934); Chaudhary & Sachar (1934); Zycha (1935); Galloway (1936); Ghatak & Roy (1939); Naumov (1939); Takeda (1949); Mui et.al., (1965);

Plate No. 6 :- Immature Jack-fruits (Artocarpus heterophyllus Lamk.) showing different stages of soft-rot disease caused by Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. in field condition.

Plate No. 7 :- Infected premature Jack-fruits (Artocarpus heterophyllus Lamk.) showing soft-rot disease caused by Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. in storage condition.



IMMATURE JACK FRUIT-SHOWING DIFFERENT STAGES
SOFT ROT OF Rhizopus.

INFECTED JACK FRUIT SHOWING SOFT-ROT
DISEASE OF Rhizopus.
STORAGE CONDITION

Zycha & Siepman (1969) and Dabinett & Angela (1973).

Zycha (1935) observed the white mycelial colony of the fungus, finally turning black. Rugmini (1956) observed the mycelial characters, sporangiophores arising in groups of 3 to 10, reaching a height of 4 mm., 24 to 40 µ microns diameter in Rhizopus artocarpi Raciborski. Shukla & Dutta (1965); Fukumoto et.al., (1967). Thompson et.al., (1982) studied the organic acid composition of Rhizopus and enzymatic properties of acid protease of Rhizopus chinensis. Ellis (1985) differentiated Rhizopus arrhizus and Rhizopus oryzae on the basis of their DNA configuration.

Studies of various environmental factors such as the effect of temperature and humidity of the fungus were also carried out by Lauritzen et.al., (1925). Tandon & Mishra (1969) reported the effect of relative humidity on the development of Rhizopus rot in case of Carrica papaya and Musa paradisiaca. Tandon & Mishra (1969); Thakur (1972); noted deep relationship of temperature and relative humidity with the development of soft-rot of apple, mango, potato, banana and tomato caused by Rhizopus arrhizus, R.oryzae and R.stolonifer. Kanwar et.al., (1973) reported the effect of temperature and relative humidity on the development of soft-rots of pomegranate caused by Rhizopus arrhizus Fischer.

Akushie & Clerk (1981) observed the effect of relative humidity on viability of Rhizopus oryzae sporangiospores. Madhukar and Reddy (1990-1991) estimated the percent rot of guava fruits during storage caused by Rhizopus species. Nishijima et.al., (1990) also studied the factors influencing development of post harvest incidence of Rhizopus soft-rot of papaya.

Sharma and Kaul (1991); Sharma et.al., (1992) observed the optimum temperature for the development of rot at 35 $^{\circ}$ C in guava fruits. Patil & Pathak (1993) observed optimum spore germination of Rhizopus arrhizus at 35 $^{\circ}$ C and 100 percent relative humidity. Sharma & Sumbali (1993) reported post harvest fungal decay of vegetables caused by Rhizopus arrhizus and Rhizopus stolonifer soft-rots of mature and fleshy vegetables under high temperature and moisture.

Effect of some semi-solid and liquid culture media on the growth and sporulation of some pathogens were earlier reported by Foster & Waksman (1939); Kaiser (1973); Munjal (1974); Lawler & Weber (1977); Fisher et. al., (1978); Reddy & Neny (1979); Prakash & Siradhana (1978); Krishna & Singh (1984); Shukla (1993) and Singh & Mahentra pal (1993).

Studies on the effect of some amino-acids on the growth of some rot causing fungi have also been reported,

Chandra and Tandon (1962); Van Andel (1966); Narsimhan (1969); Weber & Gunasekaran (1972); Vidhyasekharan (1977); Agarwal & Dhamija (1978); Mehta & Mehta (1979); Taneja et.al., (1983); Ram Pravesh & Kuleshwar Prasad (1991) and Mandavia et.al., (1992).

Studies on antifungal activity of water soluble extracts of some plants on the growth of fungi causing soft-rots were also observed by Ahmad & Sultana (1964); Davis & Smoot (1971); Melin & Krupa (1971); Lewis & Papavizas (1971); Shekhawat & Prasada (1971); Krupa et.al., (1973); Murthy & Amonkar (1974); Godfrey (1974); Dixit & Tripathi (1975); Appleton & Tansely (1975); Tansely (1975); Mishra & Dixit (1976); Tripathi et.al., (1978); Mishra & Tiwari (1978); Agarwal (1978); Singh & Singh (198Ø); Kumar & Sachan (198Ø); Narain et.al., (1981); Bhowmick & Chaudhary (1982); Singh et. al. (1983); Singh & Pathak (1984); Awasthi & Chester (1984); Ahmed & Graing (1986); Natrajan & Lalithakumari (1987); Jagannathan & Narsimhan (1988); Lakshmann & Mohan (1988); Lakshmann (199Ø); Dubey & Dwivedi (1991); Manian & Udaiyan (1991). Patil et.al., (1992); found that plant extracts of Ocimum sanctum was able to control the Rhizopus rot. They also found that this extract inhibit the biosynthesis of polyamine in Rhizopus arrhizus Fischer. Jiratko et.al., (1992) reviewed the use of various plant

extracts to control the fungal and bacterial pathogens of vegetables and fruits.

Effect of cultural filterats of some fungi on the growth of Rhizopus and other fungi causing soft rot were carried out by Porter & Carter (1938); Johnson & Curl (1972); Narain & Prakash (1968); Saksena (1969); Mitchell (1973); Abraham (1978); Mathur & Sarbhoy (1978); Tong-Kwee & Rohrbock (198Ø). Mandal & Das Gupta (1982); Singh & Gupta (1984); Pusey & Wilson (1984); Singh & Deverall (1984); Janisiewicz (1985); Wilson & Pusey (1985); Utkehede & Sholberg (1986); Janisiewicz (1987); Wilson et.al., (1987); Janisie-wicz & Roitman (1987); Janisie-wicz (1988, a & b); Wisniewski et.al., (1989); Wilson & Chalutz (1989); Chalutz & Wilson (199Ø); Mc Laughlin et.al., (199Ø, a & b); Jeffries & Jeger (199Ø); Roberts (199Ø, a & b); Doshi & Singh (1991); Nguyen & Chamel (1991); Wilson et.al., (1991); Wisniewski et.al., (1992); Jiratko & Vesela (1992); Ali & Singh (1992); Singh et.al., (1992); Wilson & Wisniewski (1992); Dwivedi (1993); Sheela et.al., (1993); Kapoor (1993) and Sen et.al., (1993).

Biological control of Rhizopus rot using cultural filterats of Enterobacter cloacae was reported by Wilson et.al., (1987). Wisniewski et.al., (1989); Roberts (199Ø); Wisniewski & Wilson (1992). Mc Laughin (199Ø) also

reported biological control of gray mold of apple by Cryptococcus laurentii and post harvest disease of peach, grape & apple with yeast Kloeckera apiculata and Candida gulliermondii.

Studies on the effect of water soluble fractions of oil-cakes and water soluble extracts of soil-amended with oil-cakes on the growth of fungal pathogen including fungi causing soft-rot were reported earlier by Calpouzos (1966); Thapilyal & Nene (1967); Grover & Aulakh (1968); Hocking (1969); Fawcett & Spencer (1969); Sanyal & Verma (1969); Singh & Singh (197Ø); Tarr (1972); Khan (1975); Thind (1977); Beye (1978); Dixit et.al., (1978); Adisa (1985); Isao & Hank (1985); Olaifa et.al., (1987); Singh & Dwivedi (1987); Sharma et.al., (1992); and Kikani & Vaishnav (1992).

Effect of some phenolic compounds on the growth of various fungal organism were reported by Walker & Link (1935); Horsfall & Rich (195Ø); Walker & Stahman (1956); Farkas (1962); Byrde (1963); Owens (1963); Patel et.al., (1964); Feharman & Dimond (1967); Vidhyasekharan (1974); Be Miller (1969); Bilgrami et.al., (1972); Umalkam et.al., (1978); Singh & Singh (1981); Friend (1981); Atri et.al., (1985); Khare (1992) and Sridharan et.al., (1993).

Studies on the control measures revealed the effectiveness of fungicides and chemicals against Rhizopus rots by Butler (1957); Chenulu & Thakur (1968); Thakur & Chenulu (197Ø b); Thakur & Chenulu (1974); Mc Millan (1975); Butani (1978); Pandey et.al., (1979); Pandey et.al., (1981); Ashok & Chenulu (1982); Roy (1986); Setty et.al., (1988); Singh & Singh (1989); Tate et.al., (1989); Sharma et.al., (199Ø); Nishijima et.al., (199Ø); Dolli & Patil (1991) and Avissar & Pesis (1991).

Similarly efficacy of hot water treatment was also observed by Sharma & Agarwal (1985); Majumdar & Pathak (199Ø) and Gorini et.al., (199Ø). Stevens et.al., (199Ø) reported UV.UV. radiation effectively decreased the percentage rot of sweet potatoes during storage caused by Rhizopus stolonifer and Fusarium solani.

In spite of some work on control measures the disease is still causing a serious problem to this crop. Therefore, in the present investigation an attempt has been made to study, some of the pathogenic aspects of the fungus. So as to find out effective control measures in order to check the spread of the pathogen of this important crop. The following work has been carried out in the present study :-

1 (A). Isolation and Identification of the pathogen along with the investigation of morphological characters of the pathogen.

1 (B). Pathogenicity Test.

1 (C). Severity of disease produced under different modes of infection in jack-fruits (Artocarpus heterophyllus Lamk) by Rhizopus stolonifer (Ehrenb. ex.fr.) Lind.

2. Effect of different culture media on the growth and sporulation of R. stolonifer.

3 (A). Effect of various temperatures on the soft-rot development in premature jack-fruits (Artocarpus heterophyllus Lamk.) In. Vivo.

(B). Effect of various temperatures on the growth and sporulation of R. stolonifer (In Vitro).

4. The studies on the host range of the soft-rot pathogen, R.stolonifer using various fruits and vegetables artificially inoculated with the test pathogen.

5. Inihibitory effect of pre-dip & post-dip treatments of the various cultural filtrates of fungal organisms on the development of soft-rots in premature jack-fruits (Artocarpus heterophyllus Lamk.) when

artificially inoculated with soft-rot pathogen R. stolonifer (In Vivo).

6. Effect of water soluble extracts of some plants known for their antifungal activity on the growth of R. stolonifer (In Vitro).

7. Effect of water soluble fractions of different oil-cakes on the growth of the R. stolonifer (In Vitro).

8. Effect of water soluble extracts of soil-amended with different oil-cakes on the growth of R. stolonifer (In Vitro).

9. Effect of water soluble extracts of soil-amended with Amino-acids on the growth of R. stolonifer (In Vitro).

10. Efficacy of some of the fungicides, phenolic compounds, and water soluble fractions of oil-cakes tested to find out effective control measures on the soft-rot development in premature jack fruits (Artocarpus heterophyllus Lamk.) (In Vivo).

MATERIALS

AND

METHODS

COLLECTION OF INFECTED PREMATURE JACK FRUITS AND MAINTENANCE OF THE STOCK CULTURE :

The diseased premature jack fruits (Artocarpus heterophyllus Lamk.) showing soft-rot were collected from local sources, brought in polythene bags, were latter sterilized with Ø.1 percent mercuric chloride solution and were kept at refrizrator running at 5 ° C in lab. The symptoms of the rot noted and the photographs were taken (Plate No. 4).

The pathogen was isolated by the following standard techniques :-

ISOLATION OF THE PATHOGENIC FUNGUS :

The premature diseased jack fruits brought in the laboratory, were washed with tap water twice to thrice, latter washed with sterilized water, were air dried and surface sterilized with Ø.1 percent mercuric chloride solution. The infected tissues were taken out with the help of sterilized knife under aseptic conditions, were latter placed on petriplates and slants containing sterilized potato dextrose agar medium.

The slants and petriplates were incubated at 30 °C, temperature and 100 percent relative humidity for 72 hours. The pathogen after 72 hours was transfered under aseptic condition to fresh slants and petriplates containing sterilized potato dextrose agar medium. The culture was isolated and maintained at 5 °C in refrizrator in the laboratory.

1 (A). **PATHOGENICITY TEST** :

Pathogenicity test were performed to confirm the pathogenicity of the causal organism. Healthy jack fruits (*Artocarpus heterophyllus* Lamk.) were collected from local sources. Fruits were washed with tap water. Surface sterilization of the fruits was done with 0.1 percent mercuric chloride solution for 1 to 2 minutes and latter washed with sterilized water. After surface sterilization a cavity was made with the sterilized cork borer, inoculum containing agar disc was placed in the cavity with the help of a sterilized needle (Granger and Horne method, 1924).

The inoculated fruits were incubated at 30 °C, temperature and 100 percent relative humidity in sterilized glass chamber for 24 to 72 hours, respectively. All the operations were carried out aseptically. The fungus (test

pathogen) was again re-isolated from the artificially inoculated fruits and compared with original culture which proved the Koch's postulates.

1 (B). **MORPHOLOGICAL STUDY OF THE PATHOGEN** :

The morphological characters of the pathogen such as stolons, rhizoids, sporangiophores, sporangia, columella and spores used in all measurements were taken from 48 - 72 hours old single spore culture of the pathogen, grown on the potato dextrose agar medium. For the morphological studies of the pathogen, temporary slids in lectophenols were prepared and stained with cotton blue. They were examined under compound microscope for observing all characters of the pathogen. Camera luceda diagrams were also made of the pathogen and the photographs were taken.

1 (C). **MODE OF INFECTION** :

Healthy fruits of uniform size were collected from the local sources. The mode of infection i.e. entrance of the pathogen in-to the host was ascertained by employing, the different methods of inoculation. For the inoculation, following types of inoculum were used in the present study :

i. **AGAR PLUG** : An agar disc (8 mm.) of 48 hour old colony of the pathogen grown on the potato dextrode agar medium served as an agar plug.

ii. **MYCELIAL SUSPENSION** : The mycelium taken from 48 hour old colony of the pathogen grown on potato dextrose agar medium were suspended and shaken in 5 ml. sterilized water for 15 minutes.

iii. **SPORES AND MYCELIAL SUSPENSION** : The 48 hour old colony of the pathogen grown on the potato dextrose agar medium were picked out with by the help of a sterilized scalpel, and thus suspended and shaken in sterilized water for 15 minutes.

The following methods were employed for the artificial inoculation. :

I. **INOCULATION ON UNINJURED FRUIT SURFACE** :

Young jack-fruits after surface sterilization were inoculated as mentioned above.

II. **INOCULATION ON INJURED HOST SURFACE** :

Injury on fruit surface was made by three ways -

(a) **Pin Prick Method** :

Multiple pricks were made on cleaned, washed and surface sterilized host surface with sterilized needle.

(b) **Cross Method** :

A small cross was made on the sterilized fruit surface with the help of sterilized scalpel.

(c) **Cavity Method (Granger and horne methods, 1924)** :

A cavity of 8 mm. diameter was made on the surface sterilized fruit surface with the help of a sterilized cork-borer of 8 mm. diameter.

In both the above cases, the fruits were inoculated by all the three types of inoculum as described earlier.

All inoculated fruits were kept in ordinary sterilized chamber and incubated at 30°C temperature and 100 percent relative humidity for 6 days. Suitable control for each experiment were also maintained by inoculating the fruits with the plane agar disc or plane water and incubated at the same condition of the temperature and relative humidity.

The data were recorded after 2,4 & 6 day's in terms of the infected symptoms appeared and the diseased intensity. For each cases three replicates were used.

2 (A). EFFECT OF DIFFERENT SEMI-SOLID & LIQUID CULTURE MEDIA ON THE GROWTH AND SPORULATION OF RHIZOPUS STOLONIFER (EHRENB. ex. Fr.) Lind.

To study the effect of different culture media on the growth of pathogen, different types of synthetic and natural culture media were prepared. The culture of the pathogen was maintained at 5°C in refrizrator in slants. Liquid and semisolid both types of culture media were used in the present study.

For the study of mycelial growth on liquid culture media. 25 ml. of each liquid media was poured in 150 ml. flask and autoclaved. Inoculation with the culture by transferring small inoculum disc cut from the two days old edge of the culture, maintained in the lab. Inoculated flasks were incubated at 30°C and 100 percent relative humidity. Three replicates were used for each cases. The mycelium was harvested on well dried and weight Whatman's filter paper no. 1. Filter paper with mycelial mat was dried overnight at 30°C temperature and reweighed to a constant weight of the pathogen.

The growth was recorded and calculated in terms of the mycelial dry weight of the test pathogen. The data were statistically analysed.

For the study of radial growth of the pathogen on different semi-solid culture media, the culture of the pathogen was transfered in petriplates containing different semi-solid media which is sterilized by standard manner, in the incubation chamber. Inoculation with the culture by transferring small inoculum disc cut from the edge of the culture, maintained in lab. The inoculated petriplates were incubated at 30° C, temperature and 100 percent relative humidity for 4,8, 12,16, 20, and 24 hours, respectively. The such inoculated petriplates in triplicate were used. PH of the media was adjusted by using citrate buffer and NaOH solution. Asparagin 100 mg. was disolved saperately in 25 ml. of absolute alcohol and sterilized water added to make 250 ml. of stock solution to add the brown's synthetic medium. The radial mycelial growth was measured in cm. with the help of a plastic centimeter scale.

The data were recorded as most and least preferable media and calculated in terms of radial mycelial growth of the test pathogen. The data were statistically analysed.

The following semi-solid culture media were used in the present study :-

1. **Brown's Synthetic Agar Medium** :

Glucose	: 2.Ø	gm.
Asparagine	: 2.Ø	gm.
K_3PO_4	: 1.25Ø	gm.
$MgSo_4 7.H_2O$	: Ø. 75Ø	gm.
Agar	: 15.Ø	gm.
Distilled water	: 1ØØØ.ØØ	ml.

2. **Czapek's - Dox Agar Medium (Thom and Roper -1945)** :

$NaNo_3$	: 2.Ø	gm.
KH_2PO_4	: 1.Ø	gm.
$MgSo_4.7H_2O$	: Ø.5	gm.
Kcl	: Ø.5	gm.
$FeSo_4.7H_2O$	: Ø.Ø1	gm.
Sucrose	: 3Ø.Ø	gm.
Agar	: 15.Ø	gm.
Distilled water	: 1ØØØ.ØØ	ml.

3. **Asthana & Hawker's Agar Medium** :

Glucose	: 5.Ø	gm.
KNo_3	: 3.5	gm.
KH_2Po_4	: 1.75	gm.
$MgSo_4.7H_2O$	: Ø.75	gm.
Distilled water	: 1ØØØ.ØØ	ml.

4. **Richard's Agar Medium** :

KNo_3	: 1Ø.Ø	gm.
KH_2Po_4	: 5.Ø	gm.
$MgSo_4$	: Ø.29	gm.
$FeCl_3$	: Trace	
Sucrose	: 3Ø.ØØ	gm.
Agar	: 2Ø.Ø	gm.
Distilled water	: 1ØØØ.ØØ	ml.

5. **Martin's Medium** :

(Peptone Dextrose Rose Bengal Agar)

KH_2Po_4	: 1.ØØ	gm.
$MgSo_4.7H_2O$	: Ø.5	gm.
1% Rose Bengal	: 3.5	ml.
Streptomycin	: Ø.3Ø	gm.
Peptone	: 5.Ø	gm.
Dextrose	: 1Ø.ØØ	gm.
Agar	: 2Ø.ØØ	gm.
Distilled water	: 1ØØØ.ØØ	ml.

6. **Sabouraud's Dextrose Agar Medium** :

(Peptone Dextrose Agar Medium)

Peptone	: 1Ø.Ø	gm.
Dextrose	: 4Ø.Ø	gm.
Agar	: 2Ø.ØØ	gm.
Distilled water	: 1ØØØ.ØØ	ml.

7. **Riker and Riker Agar Medium (Riker and Riker, 1936)** :

Potatoes (peeled and sliced)	: 2Ø.ØØ	gm.
Dextrose	: 2Ø.ØØ	gm.
Agar	: 2Ø.ØØ	gm.
Distilled water	: 1ØØØ.ØØ	ml.
PH	: 6.5	

8. **Malt Extracts Agar Medium** :

Malt extracts	: 2Ø.ØØ	gm.
Agar	: 15.ØØ	gm.
Distilled water	: 1ØØØ.ØØ	ml.

9. Potato Dextrose Agar Medium :

Potatoes (Peeled and sliced)	: 20.00	gm.
Dextrose	: 20.00	gm.
Agar	: 20.00	gm.
Distilled water	: 1000.00	ml.

10. Oat Meal Agar Medium (Riker and Riker, 1936) :

Oat meal	: 30.00	gm.
Yeast extracts	: 1.0	gm.
Agar	: 20.00	gm.
Distilled water	: 1000.00	ml.

11. Corn Meal Agar Medium :

Corn meal	: 30.00	gm.
Agar	: 20.0	gm.
Distilled water	: 1000.00	ml.

12. Soyabean Meal Agar Medium :

Soyabean meal	: 15.00	gm.
Agar	: 20.00	gm.
Distilled water	: 1000.00	ml.

13 (a). Host extracts (scale) Agar Medium :

(Jack-fruit was used as a medium)

Jack fruit scale (macerated and shakened)	: 15.00	gm.
Agar	: 20.00	gm.
Distilled water	: 1000.00	ml.

13 (b). Host extracts (seed) Agar Medium :

Jack-fruit seeds (macerated

and shakened)	: 15.Ø	gm.
Agar	: 2Ø.Ø	gm.
Distilled water	: 1ØØØ.ØØ	ml.

13 (c). Host extracts pulp Agar Medium :

Jack-fruits pulp (macerated and shakened.)	: 15.Ø	gm.
Agar	: 2Ø.Ø	gm.
Distilled water	: 1ØØØ.ØØ	ml.

All these media were also used in liquid form in which agar was not used.

3 (A). EFFECT OF VARIOUS TEMPERATURES ON THE DEVELOPMENT OF SOFT-ROT IN PREMATURE JACK FRUITS (ARTOCARPUS HETEROPHYLLUS LAMK.) (IN VIVO) :

To study the effect of various temperatures and their influence on the development of Rhizopus rot, immature jack fruits were collected from the local sources were brought in moist sterile poythene begs (moistened with sterilized water). Fruits were washed with tap water and then surface sterilized with Ø.1 percent mercuric chloride solution for five minutes latter on inoculated by means of mycelial disc cut from the edge of the culture, grown on the potato dextrose agar medium in standard manner (Dannis and Harris, 1979).

The inoculated fruits were incubated for Ø° C

to 45 °C in incubators maintained at different temperatures. These were examined after 12,24, 48 and 72 hours, respectively.

The data were recorded in terms of most effective temperature, causing soft-rot in the premature fruits and temperature which was least effective. Three replicates were kept for each cases. The degree or rotting in each cases was measured in terms of area of rot (lesion diameter) in cm. as a mean value of three replicates. Suitable control were kept simultaneously for the purpose of comparison. The data were statistically analysed.

3 (B). **EFFECT OF VARIOUS TEMPERATURES ON THE GROWTH AND SPORULATION OF RHIZOPUS STOLONIFER (Ehrenb. ex. Fr.) Lind. (IN VITRO) :**

To study the in vitro effect of various temperatures on the growth and sporulation of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. pathogen were inoculated in potato dextrose agar plates and incubated for Ø°C to 45 °C in incubators at different temperatures. These plates were examined after 4, 12, 24, 48 and 72 hours, respectively. The data were recorded in terms of most and least effective temperature and calculated in terms of radial diameter of the

test pathogen. The data were statistically analysed.

4. **THE STUDIES ON HOST RANGE OF THE SOFT -ROT PATHOGEN, RHIZOPUS STOLONIFER (Ehrenb. ex. Fr.) Lind. USING VARIOUS FRUITS AND VEGETABLES ARTIFICIALLY INOCULATED WITH THE TEST PATHOGEN :**

To study the host range of the pathogen, a fresh culture of the pathogen was prepared on Potato dextrose agar medium for 48 hour old culture of the pathogen, Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind.. The mycelial disc cut from the edge of the culture grown on the potato-dextrose agar medium was used to inoculate the different fruits and vegetables collected from local sources, were tested for the host range of the test pathogen. Healthy and young fruits and vegetables of uniform size and weight were procured from the local market.

The fruits and vegetables viz., Momordica charantia Linn. (bitter gourd), Luffa cylindrica (L.) Roem. (sponge gourd), Citrullus vulgaris Linn. var. fistulosus Duth. & Full. (round gourd), Trichosanthes dioica Roxb. (pointed gourd), Coccinia indica Wt. Arn. (little gourd), Cucumis sativus Linn. (khira), Solanum turberosum Linn. (potato), Solanum melongena Linn. (brinjal), Lycopersicon esculentum Mill. (tomato), Capsicum sp. Linn. (Chilli), Pyrus malus

Linn. (apple), Pyrus communis Linn. (pear), Citrus sinensis (L.) Osbeck., (sweet orange), Citrus limon (L.) Burn. f. (lemon), Allium cepa Linn. (onion), Allium sativum Linn. (garlic), Emblica officinalis Gaertn, (aonla), Punica granatum Linn. (anar), Musa paradisiaca Linn. (banana), Carissa carandus Linn. (karonda), Carica papaya Linn. (papaya), Calocasia antiquorum Linn. (arvi), Zingiber officinale Rosc. (zinger), Raphanus sativus Linn. (mooli), Abelmoschus esculentus (L.) Moench. (okra) and Mangifera indica Linn. (mango). were washed with tap water twice to thrice and subsequently surface sterilized with Ø.1 percent mercuric chloride solution were latter air dried and their weight was separately recorded. These fruits and vegetables were latter inoculated with culture of the test pathogen by cavity method (Granger and Horne, 1924). The inoculated fruits and vegetables were latter incubated at 3Ø° C, temperature and 1ØØ percent relative humidity for two to four day's. After two to four days of incubation period, weight of fruits and vegetables were again recorded. Three replicates were used for each cases. Suitable control (uninoculated fruits and vegetables) were used, simultaneously for the purpose of comparison. The data were statistically analysed. The data were recorded in terms of percent rot and calculated by the following, Gaur and chenulu (1982) method :

$$\text{Percent rot} = \frac{W-w}{W} \times 100$$

where,

W = Initial weight of the fruit/vegetable and

w = Weight of fruit/vegetables after the removal of infected portion.

5. INHIBITORY EFFECT OF CULTURAL FILTRATES OF VARIOUS FUNGAL ORGANISMS ON THE DEVELOPMENT OF SOFT-ROT IN PREMATURE JACK-FRUITS WHEN ARTIFICIALLY INOCULATED WITH SOFT-ROT PATHOGEN, RHIZOPUS STOLONIFER (IN VIVO) :

To study the inhibitory effect of the cultural filtrates of various fungal organisms were isolated from the different types of soil, adjacent to jack-fruit trees [by soil dilution methods, soil dilution plate method, Waksman, (1922) : Brierley (1923)] and soil plate methods, Warcup, (1950) on the soft-rot development in premature jack-fruits viz., Aspergillus niger, Fusarium sp., Alternaria sp., Cladosporium sp., Nigrospora sp., Chaetomium sp., Stylopage sp., Curvularia sp., Helminthosporium tetramera and Aspergillus flavus on the soft-rot development in premature jack-fruits, subsequently these fungal organisms were grown on czapek's liquid medium for seven days, latter on filtered and each of filtrate was diluted by adding 150 ml. of sterilized water.

Immature jack-fruits previously inoculated with test pathogen, Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. by standard method (Dannis and Harris, 1979) were dipped in the above filtrates for 30 minutes and incubated at 30°C, temperature and 100 percent relative humidity.

Immature jack-fruits pre dipped in the above culture filtrates for 30 minutes were latter on inoculated with, R. stolonifer by the above method were incubated at 30°C, temperature and 100 percent relative humidity.

Inoculated jack fruits dipped in sterilized water (suitable control) used, simultaneously for purpose of comparison. Three replicates of each treatments were kept.

The data were recorded and calculated percent inhibition in terms of percents rot of test pathogen. Data were calculated following method based on, Vincent (1947).

$$I = \frac{C-T}{C} \times 100$$

where,

I = Percent inhibition.

C = Control ("Normal" percent rot).

T = Treated ("Influenced" percent rot).

6. EFFECT OF WATER SOLUBLE EXTRACTS OF SOME PLANTS ON THE GROWTH OF RHIZOPUS STOLONIFER (IN VITRO) :

The effect of water soluble extracts of some plants known for their antifungal activity was studied on the growth of pathogen. For the preparation of water soluble extracts of plants, green leaves and stems of 17 plants viz., Lantana indica Roxb., Launea asplenifolia Hook f., Adhatoda vasica Nees., Calotropis procera (Ait.) R., Solanum xanthocarpum Schrad. & Wendl., Jatropha gossipifolia Linn., Barleria prionitis Linn., Parthenium hysterophorus Linn., Azadirachta indica A. Juss., Clerodendron phlolytis Linn., Catharanthus roseus G.Don., Ocimum sanctum Linn., Allium sativum Linn., Allium cepa Linn., and Zingiber officinale were collected from local sources. 25 gm. of each sample was washed with tap water twice to thrice and latter with the sterilized water, subsequently air dried and macerated separately in 150 ml. of sterilized water were latter on filtered through muslin cloth and then by Whatman's filter paper no. 1. Three arbitrary dilutions of this concentrate viz., 25% (S1); 50% (S2); 75% (S3); and 100% (S4) were made by adding requisite amount of sterilized water, 5 ml. of this extracts was latter on poured into sterilized petriplates subsequently 15 ml. of the sterilized melted potato dextrose agar medium was poured into each petriplates

under the aseptic condition. The petriplates were then gently rotated so that filtrate got mixed well with the medium. After solidification of agar the culture of the pathogen was inoculated in the centre of the petriplates as stated in the standard manner. The inoculated petriplates were incubated at 25-30°C, temperature and 100 percent relative humidity for 72 hours, respectively.

Untreated petriplates having the sterilized potato dextrose agar medium and inoculated with test pathogen served as control, simultaneously for the purpose of comparison. Three replicates were used for each treatments. The data were statistically analysed.

The data were recorded and calculated as percent inhibition in terms of radial mycelial growth of test pathogen over control by the following method based on, Vincent (1947).

$$I = \frac{C - T}{C} \times 100$$

where,

I = Percent inhibition of mycelial growth

C = Control ("Normal" mycelial growth in cm.).

T = Treated ("Influenced" mycelial growth in cm.).

7. EFFECT OF WATER SOLUBLE FRACTIONS OF DIFFERENT OIL-CAKES ON THE GROWTH OF RHIZOPUS STOLONIFER (IN VITRO) :

For obtaining different concentrations of water soluble fractions of oil-cakes 2.5, 5 and 10 gm. powdered oil-cakes viz., Madhuca indica J.F. Gmel. (mahua-cake), Ricinus communis Linn. (castor-cake), Arachis hypogea Linn. (groundnut-cake), and Azadirachta indica A. Juss. (neem-cake) were transfered to Erlenmayer flask containing 100 ml. of sterilized water, mixture was shaken in a mechanical shaker for 10 minutes were plugged with cotton and autoclaved latter stored at 25-30° C for 2,6,10 & 15 days, respectively. After storage period water soluble fractions of oil-cake was filtered with Whatman's filter paper no. 1. The filtrates were used to study its effect on growth of the test pathogen.

About 5 ml. of this filtrates was poured into sterilized petriplates subsequently 15 ml. of the sterilized, melted potato dextrose agar medium was poured into each petriplates. The petriplates were then gently rotated so that filtrate got mixed well with the medium under the aseptic conditions. After solidification of agar, the culture of the pathogen was inoculated in the centre of the petriplates as stated in earlier in the standard manner. The inoculated petriplates were incubated at 25-30° C, temperature and 100%

relative humidity for 24 hours, respectively. Untreated petriplates (without any fractions) inoculated with the test pathogen was used as control, simultaneously for the purpose of comparison. Three replicates were used for each treatments. The radial mycelial growth was measured in cm. with the help of a plastic centimeter scale.

The data were recorded and calculated percent inhibition in terms of radial mycelial growth of test pathogen over control by the same methods as follows in the case of plant extracts.

8. **EFFECT OF WATER SOLUBLE EXTRACTS OF SOIL AMENDED WITH DIFFERENT OIL-CAKES ON THE GROWTH OF RHIZOPUS STOLONIFER (IN VITRO) :**

The water soluble extracts of soil amended with different oil-cakes were prepared by mixing 2.5, 5.Ø & 1Ø.Ø gm. of different oil-cakes (mentioned in the earlier experiment) with 1ØØ gm. of sterilized soil in an Erlenmayer flasks, latter 15Ø ml. of sterilized water was added to this flasks were pluged with cotton and stored at 25-3Ø°C, latter water soluble extracts of soil amended with oil cakes was filtered by Whatman's filter paper no. 1. After 2, 6, 1Ø & 15 days of storage period, respectively. The filtrates was used its effects on the growth of pathogen as described in the earlier experiment.

About 5 ml. of this filtrates was poured to the sterilized petriplates subsequently 15 ml. of the sterilized, melted potato-dextrose agar medium was poured into each petriplates. The petriplates were then gently rotated so that filtrate got mixed well with the medium under aseptic conditions. After solidification of agar the culture of the test pathogen was inoculated in the centre of the petriplates as stated earlier in the standard manner. The inoculated plates were incubated at 25-30°C for 24 hours, respectively. Untreated petriplates (without any extracts) inoculated with the test pathogen was used as control, simultaneously for the purpose of comparison. Three replicates were used for each treatments.

The Data recorded and calculated percent inhibition in terms of radial mycelial growth of test pathogen over control by the same methods as follows in the case of plant extracts. The data were statistically analysed.

9. **EFFECT OF WATER SOLUBLE EXTRACTS OF SOIL AMENDED WITH DIFFERENT AMINO ACIDS ON THE GROWTH OF RHIZOPUS STOLONIFER (IN VITRO) :**

Extracts of soil amended with different amino-acids were prepared by mixing 500 mg. of different amino-acids with 125 gm. of sterilized soil in Erlenmayer flasks.

Latter 500 ml. of sterilized water was added to these flasks, plugged with cotton and stored at 30°C. The extracts were filtered after 2,6,10 and 15 days of storage period by Whatman's filter paper no.1. Filtrates were used to study their effects on the radial mycelial growth of the pathogen stated in the earlier experiments. There were three replicates used for each treatments. Test pathogen grown on sterilized potato dextrose agar medium without the addition of the above extracts were used as control, simaltaneously for the purpose the comparison.

The data were recorded and calculated as percent inhibition in terms of radial growth of test pathogen over control by the same methods as follows in the case of plant extracts.

10 (A). **EFFICACY OF THE FUNGICIDES ON THE DEVELOPMENT OF SOFT-ROT IN PREMATURE JACK-FRUITS (IN VIVO) :**

Five fungicides viz., Bavistin, Dithane M_{-45} Thiram, Captan and Benlate in three different concentration viz., 0.2% (S1); 0.3% (S2) and 0.5% (S3) were used to test their efficacy in *in vivo* condition. The different concentrations of fungicides were used for dip treatments and tested against the test pathogen as pre and post dip inoculation protectants, with a view to observe the effect on

soft rot development in jack fruits.

In prior dip treatments, the healthy and fresh fruits collected from local sources were sterilized with Ø.1 percent mercuric chloride solution and latter washed with sterilized water, air dried in aseptic conditions and dipped in the fungicidal solution of different concentrations for 3Ø minutes. After removing these fruits from fungicides they were allow to dry at room temperature under aseptic conditions. The fruits were then inoculated with standard methods, as stated earlier experiments. The inoculated fruits were incubated at 3Ø°C and 1ØØ percent relative humidity for 24, 48 and 72 hours, respectively.

In post dip treatments, the healthy fruits were surface sterilized with Ø.1 percent mercuric chloride solution and latter washed with sterilized water, air dried in aseptic conditions. Fruits were inoculated with standard method, as stated earlier experiments with test pathogen. Inoculated fruits after 3Ø minutes dipped in different concentration of fungicidal solution. After 3Ø minutes, removing these fruits from fungicides air dried under aseptic conditions. Inoculated and treated fruits were incubated at 3Ø°C, temperature and 1ØØ percent relative humidity for 24,48 and 72 hours, respectively.

The inoculated and untreated fruits were kept served as control, simultaneously for the purpose of comparison. Three replicates were used for each treatments.

The data were recorded and calculated percent inhibition in terms of percent rot over control by the following method based on, Vincent (1947).

$$I = \frac{C - T}{C} \times 100$$

where,

I = Percent inhibition

C = Control ("Normal" percent rot)

T = Treated ("Influenced" percent rot)

10 (B). EFFICACY OF THE PHENOLIC COMPOUNDS ON THE DEVELOPMENT OF SOFT-ROT IN PREMATURE JACK-FRUITS (IN VIVO) :

Four phenolic compounds viz., Catechol, Napthol, Pyrogallol and Resorcinol at three different concentrations viz, 250 ppm. (S1), 500 ppm. (S2) & 750 ppm. (S3) were used to test their efficacy in in vivo condition. The suspensions of the phenolic compounds were used for dip treatments and tested against the test pathogen as pre and post dip inoculation protectants, with a view to observe the effect on soft rot development in premature jack fruits.

All the procedures were the same as discribe in case of fungicides.

1Ø (C). EFFICACY OF THE WATER SOLUBLE FRACTIONS OF DIFFERENT OIL-CAKES ON THE DEVELOPMENT OF SOFT-ROT IN PREMATURE JACK-FRUITS (IN VIVO) :

The water soluble fractions of four oil-cakes viz., Arachis hypogea Linn. (groundnut-cake), Ricinus cummunis Linn., (castor-cake), Madhuca indica J.F.Gmel. (mahua-cake), Azadirachta indica A.Juss. (neem-cake), was prepared by mixing 2.5, 5, and 1Ø gm. cake in sterilized water to see the effect of these extracts on the soft-rot development in the premature jack fruits.

The different concentrations of water soluble fractions of oil-cakes were used for the pre and post dip treatments and tested against the test pathogen as pre and post dip inoculation protectants, with a view to observed the effects on the soft rot development in the premature jack fruits.

All the procedures were the same as described in the case of fungicides.

EXPERIMENTAL RESULTS

1 (A). PATHOGENICITY TEST :

Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. isolated from infected premature jack-fruits (Artocarpus heterophyllus Lamk.) was found responsible for causing severe soft - rot disease on this fruit. Artificially inoculated jack-fruits showed characteristics symptoms of soft-rot which were identical in the appearance with original form from which isolation was made thus it confirmed the pathogenicity test. The pathogenic behaviour of the pathogen and inoculation of healthy fruits was further confirmed by repeated isolations of the pathogen. The positive results of pathogenicity test confirmed the Koch's postulates (Plate No. 8).

1 (B). MORPHOLOGY OF THE PATHOGEN :

The morphology of the pathogen were studied from 18 to 72 hours old culture grown on potato dextrose agar medium plates isolated from infected premature jack fruits (Artocarpus heterophyllus Lamk.). The pathogen showed great variation in morphology. The colony of the pathogen white to begin and latter blackish brown. Mycelium was developed a thick mat on the fruit surface; turft at first white in colour latter forming blackish brown, formed a layer of 2-3

Plate No. 8 :- Pathogenicity test :

[Development of soft-rot in premature Jack-fruits (Artocarpus heterophyllus Lamk.) after inoculation with isolates, Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. of premature fallen Jack-fruits.]

DEVELOPMENT OF SOFT-ROT
IN
YOUNG JACK-FRUITS

AFTER INOCULATION WITH ISOLATES
PREMATURE FALLEN JACK FRUITS

CONTROL
UN-INOCULATED

INOCULATED
AND
INCUBATED FOR 7 Day's

Plate No. 9 :- Petriplate showing pure culture of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. grown on potato dextrose agar (P.D.A.) medium, isolated from infected premature jack-fruits.

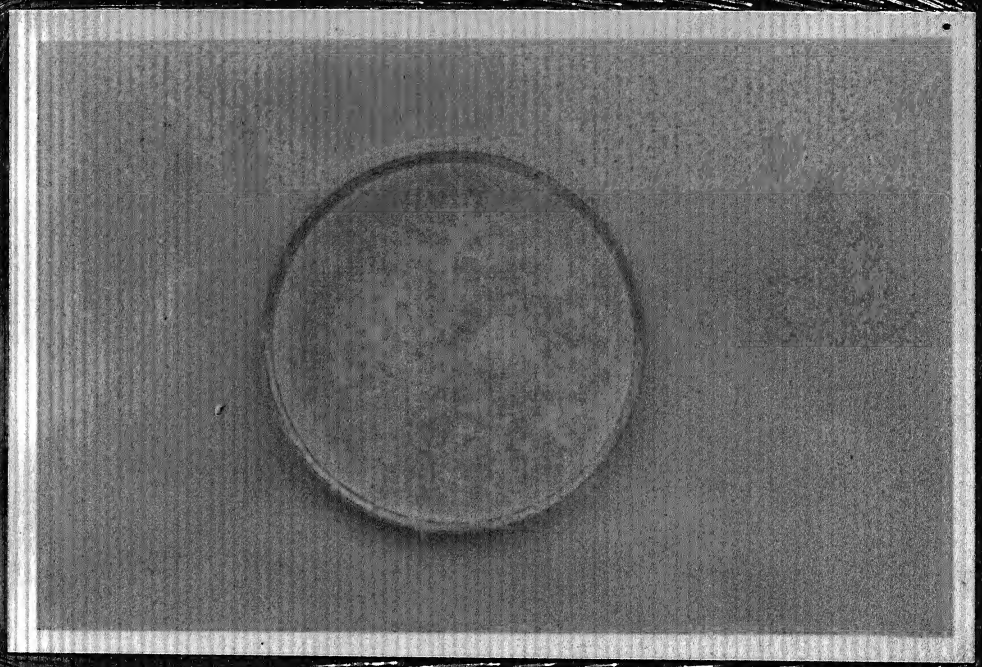


Fig. No. 1 :- Morphology of the soft-rot pathogen, Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind.

A = Habit of growth

B = Sporangiophores showing rhizoids (10 x 10 X)

C = Sporangium after wall rupture, showing columella and spores. (45 x 10 X)

D = Inveginated columella. (45 x 10 X)

c. = Columella; r. = Rhizoidal hyphae;

s. = Sporangium; sp. = Spore; spo. = Sporangiophore;

st. = Stolon.

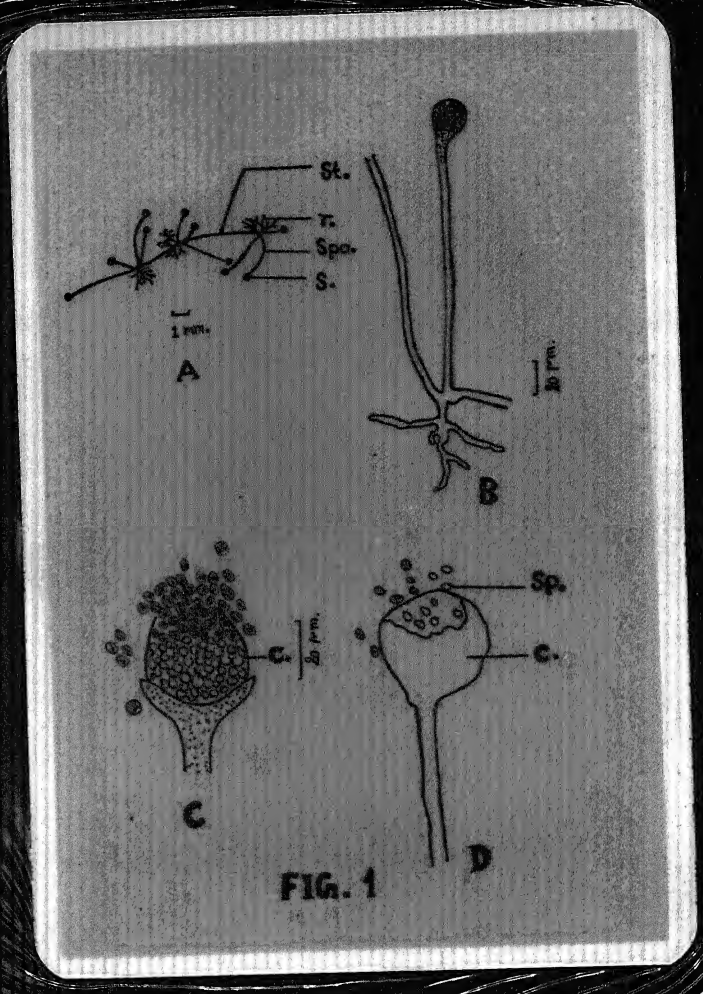


FIG. 1

cm. in thickness; stolons creeping and recurving to the substrate. Rhizoids at first were colourless then turning brownish, about 133.53 µ in height and 98.59 µ thick. Sporangiophores were usually in groups of 3-5, unbranched, typically opposite the rhizoids, about 5Ø.41 µ in height and 19.3 µ in width, sporangia were white in colour at first latter blackish brown at maturity, about 1Ø2.33 µ in height and 96.72 µ in width. Columella ovate to hemispherical, about 97.34 µ height and 98.59 µ in width ; Spores were round or oval, grayish, about 4.Ø56 µ in height and 3.276 µ in width. More or less these all measurements of rhizoids, sporangiophores, soprangia, columella and spores are tally with the measurements of Rhizopus stolonifer which is mentioned in the book "Mucorales of India" (Tandon, 1968). However, there is some variation observed during present investigation in the measurements of all parts of fungus point out the occurrence of a new variety of R. stolonifer which again differs in morphology with R. stolonifer Ehrenb. var. minutus Chaudhary.

1 (C). **MODE OF INFECTION** :

To evaluate the most effective techniques of inoculation and modes of infection of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind., number of inoculation experiments were conducted. The data presented in the Table No. 1 showed

TABLE NO. 1. : SEVERITY OF DISEASE PRODUCED UNDER DIFFERENT MODES OF INFECTIONS IN JACK FRUITS (ARTOCARPUS HETEROPHYLLUS LAMK.) BY RHIZOPUS STOLONIFER (Ehrenb. ex. Fr.) Lind. :

S.NO.	TYPES OF INOCULUM USED	MODES OF INFECTION	INCUBATION PERIOD (d)	SYMPTOMS PRODUCED ON HOST BY RHIZOPUS STOLONIFER	SEVERITY OF DISEASE
1.	Agar plug (inoculum discs of 8 mm. diameter)	On uninjured host	2	No symptoms	-
			4	No symptoms	-
			6	Less mycelial growth over fruit surface	+
	------ Do ---------	Pin-prick method	2	Less mycelial growth over fruit surface	+
			4	Large water soaked areas	++
			6	Fruits rotted completely and surface covered by mycelial turft.	+++
	----- Do ---------	Cross method	2	Less mycelial growth over fruit surface	+
			4	Large water soaked areas with mycelial mat	++
			6	Fruits rotted completely and surface covered by mycelial truft.	+++
	----- Do ---------	Cavity method	2	Fruit rotted completely and surface covered by mycelial truft.	+++
			4	Fruit rotted completely and oozed bad odour.	++++
			6	Fruit rotted completely and oozed bad odour.	++++
2.	Mycelium with spore suspension.	On uninjured host	2	No symptoms	-
			4	No symptoms	-
			6	Less mycelial growth over fruit surface	+

Contd.

	----- Do ---------	Pin-prick method	2	No symptoms	-
			4	Less mycelial growth over fruit surface	+
			6	Large water soaked areas with mycelial mat	++
	----- Do ---------	Cross method	2	No symptoms	-
			4	Less mycelial growth over fruit surface	+
			6	Small water soaked areas with mycelial mat	++
	----- Do ---------	Cavity method	2	Water soaked areas covered with mycelial truft	++
			4	Fruits completely rotted	+++
			6	Fruits completely rotted and oozed bad odour.	++++
3.	Mycelial suspension	On uninjured host	2	No symptoms	-
			4	No symptoms	-
			6	Less mycelial growth over fruit surface	+
	----- Do ---------	Pin-prick method	2	No symptoms	-
			4	Less mycelial growth on fruit surface	+
			6	Water soaked areas covered with mycelial mat	++
	----- Do ---------	Cross method	2	No symptoms	-
			4	Less growth of mycelium over fruit surface	+
			6	Small water soaked areas developed	++

Contd.

----- Do ---------	Cavity method	2	Less growth of mycelium over fruit surface	+
		4	Large water soaked areas with mycelial mat	++
		6	Fruits rotted completely and surface covered with mycelial truft.	+++

Each test carried out in triplicate.
Inoculated fruits were incubated at 3Ø C, temprature and 1ØØ% relative humidity.
Severity of disease was rated according to the following scale :-
- : No symptoms ; + : Less severe ; ++ : Moderate severe ; +++ : Highly severe and ++++ : Most severe stage of disease.
d = days.

that inoculation on uninjured jack-fruits (Artocarpus heterophyllus Lamk.) surface could not show any significant growth of the pathogen causing soft-rot.

The significant results were obtained when inoculations were carried out on injured fruit surface, out of three methods tested i.e. cavity method, pin-prick method and cross method. The maximum growth of the fungus resulting in rot was observed in which inoculation was done by cavity method.

Out of three techniques tested (Table No. 1) maximum rotting resulted when inoculum was used as an agar disc cut from the edge of culture growing on petriplates followed by mycelium with spore suspension and subsequently mycelial suspension.

The optimum growth resulting in soft-rot were observed by cavity method using agar disc as an inoculum. No symptoms were observed in the uninoculated fruits, or the fruits were inoculated with plane agar disc and sterile water.

2 (A). **EFFECT OF DIFFERENT SEMI-SOLID CULTURE MEDIA ON THE GROWTH AND SPORULATION OF RHIZOPUS STOLONIFER** (Ehrenb. ex. Fx.) Lind. :

The results of the experiments presented in the Table No. (2); Plate No. (1Ø); Fig. No. (2a) revealed that inoculation and subsequent incubation of petriplates (having different types of semi-solid culture media) with test pathogen, resulted in the growth and sporulation of R. stolonifer. Data were recorded in terms of radial mycelial growth and sporulation of the test pathogen.

It is clear from the Table No. (2) that Potato dextrose agar medium and Malt extract agar medium were found to be highly favourable; Ashthana & Hawker's agar medium, Martin's agar medium, Sabouraud's dextrose agar medium, Riker & Riker agar medium, Corn meal agar medium and Host extracts (A,B & C) agar medium were found to be moderately favourable; Czapek's Dox agar medium and Oat meal agar medium were found to be less favourable, while Richard's agar medium was found to be unfavourable for the radial mycelial growth of the test pathogen.

The data in the table number (2) showed that the radial mycelial growth was Ø.1, 1.1, 1.2, 1.3, 1.3 & 1.4 cm.; it was Ø.Ø, Ø.Ø, Ø.Ø, Ø.Ø, Ø.Ø, & Ø.Ø cm.; It was Ø.Ø, Ø.Ø, Ø.1, 1.2, 1.5, & 2.2 cm.; It was Ø.1, 1.1, 1.9, 2.5, 3.3 & 4.1 cm.; It was Ø.5, 1.2, 3.3, 3.7, 3.8, & 3.9 cm.; It was Ø.2, Ø.4, 1.2, 1.8, 2.7, & 3.7 cm.; It was Ø.16, Ø.7, 1.4,

TABLE NO. 2 : EFFECT OF DIFFERENT SEMI-SOLID CULTURE MEDIA ON THE RADIAL MYCELIAL GROWTH AND SPORULATION OF RHIZOPUS STOLONIFER :

S.NO.	CULTURE MEDIA	DIAMETER OF THE RADIAL MYCELIAL GROWTH (cm.)						SPORULATION	RATING SCALE
		After 4 hrs.	After 8 hrs.	After 12 hrs.	After 16 hrs.	After 20 hrs.	After 24 hrs.		
1.	Brown's agar medium	Ø.1	1.1	1.2	1.3	1.3	1.4	Nil	+
2.	Richards agar medium	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Nil	-
3.	Czapek's Dox agar medium	Ø.Ø	Ø.Ø	Ø.1	1.2	1.5	2.2	Poor	++
4.	Malt extracts agar medium	Ø.1	1.1	1.9	2.5	3.3	4.1	Excellent	++++
5.	Asthana & Hawkers agar medium	Ø.5	1.2	3.3	3.7	3.8	3.9	Good	+++
6.	Martin's agar medium	Ø.2	Ø.4	1.2	1.8	2.7	3.7	Good	+++
7.	Sabouraud's dextrose agar medium	Ø.16	Ø.7	1.4	1.5	1.6	3.2	Good	+++
8.	Corn meal agar medium	Ø.1	1.3	1.8	2.Ø	2.9	3.1	Good	+++
9.	Riker & Riker agar medium	Ø.Ø3	1.2	2.3	2.5	3.4	3.9	Good	+++
1Ø.	Soyabean meal agar medium	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø4	Ø.Ø8	Nil	+
11.	Potato dextrose agar medium	Ø.Ø3	1.2	2.3	3.4	3.9	4.5	Excellent	++++

Contd.

12.	Oat meal agar medium	Ø.23	Ø.25	Ø.7	1.5	1.9	2.Ø	Poor	++
13.A	Host extracts (scale) agar medium	1.2	2.Ø	2.8	3.Ø	3.4	3.5	Good	+++
13.B	Host extracts (seed) agar medium	Ø.8	1.Ø	1.2	1.9	2.5	3.1	Good	+++
13.C	Host extracts (pulp) agar medium	Ø.Ø3	Ø.5	1.Ø	1.5	2.5	3.Ø	Good	+++
	CD at 5% level	Ø.26	Ø.54	Ø.92	1.19	1.2Ø	1.Ø9	-	
	CD at 1% level	Ø.37	Ø.76	1.3Ø	1.67	1.68	1.53	-	

Note : Each reading is an average of three replicates.
Incubation temprature was 3Ø C
Rating scale :-
++++ : Highly favourable ; +++ : Moderately favourable ;
++ : Less favourable ; + : Least favourable ; - : Unfavcurable.

Fig. No. 2 (a) :- Effect of different semi-solid culture media on the radial mycelial growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind.

A = Brown's agar medium

B = Richard's agar medium

C = Czapek's Dox agar medium

D = Malt extracts agar medium

E = Asthana & Hawker's agar medium

F = Martin's agar medium

G = Sabouraud's Dextrose agar medium

H = Corn meal agar medium

I = Riker & Riker agar medium (1936)

J = Soyabean meal agar medium

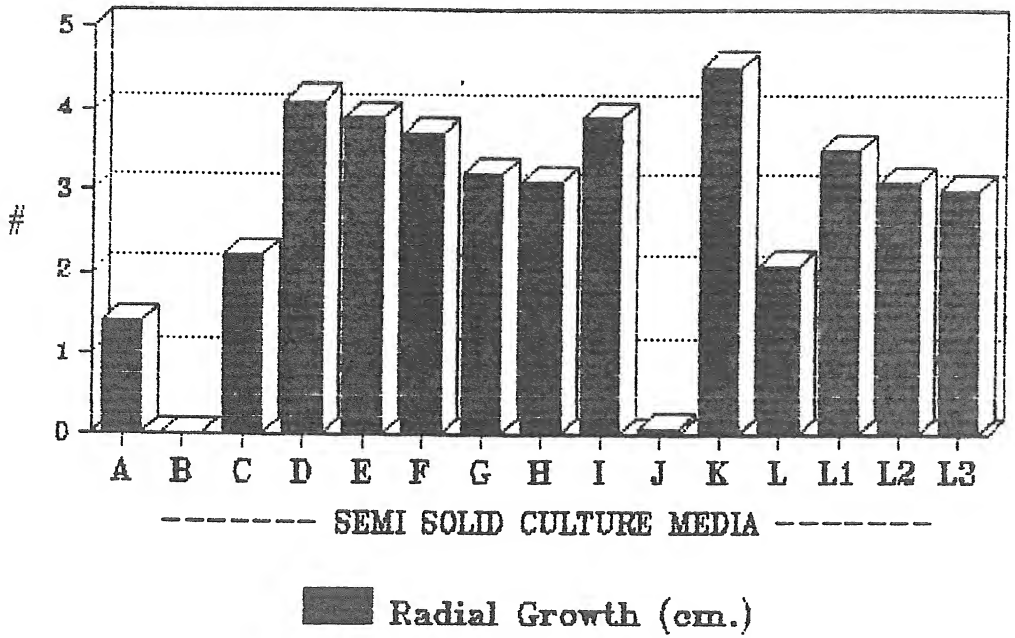
K = Potato dextrose agar medium

L = Oat meal agar medium

L1 = Host extracts (scale) agar medium

L2 = Host extracts (seed) agar medium

L3 = Host extract (pulp) agar medium

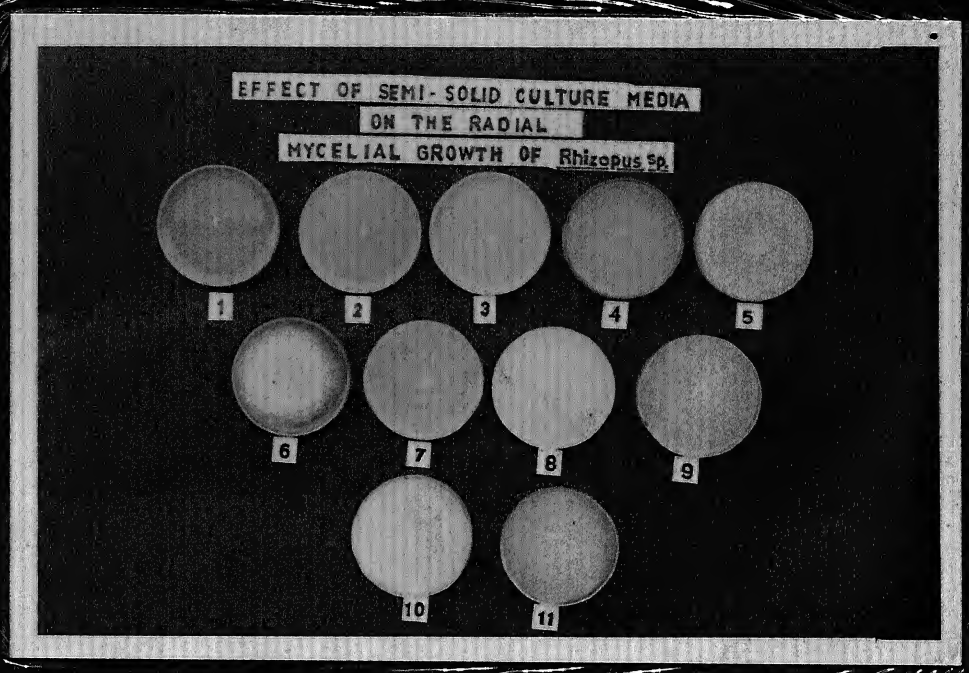


- RADIAL MYCELIAL GROWTH OF THE PATHOGEN AFTER 24 HRS.(CM)

Fig. No. 2(a)

Plate No. 1Ø :- Effect of semi-solid culture media on the radial mycelial growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind.

1. Brown's agar medium
2. Richard's agar medium
3. Czapek's Dox agar medium
4. Malt extracts agar medium
5. Asthana and Hawker's agar medium
6. Martin's agar medium
7. Sabouraud's dextrose agar medium
8. Corn meal agar medium
9. Riker and Riker agar medium (1936)
1Ø. Soyabean meal agar medium
11. Potato dextrose agar medium


EFFECT OF SEMI-SOLID CULTURE MEDIA
ON THE RADIAL
MYCELIAL GROWTH OF Rhizopus sp.
1
2
3
4
5
6
7
8
9
10
11

1.5, 1.6 & 3.2 cm.; It was Ø.1, 1.3, 1.8, 2.Ø, 2.9, & 3.1 cm.; It was Ø.Ø3, 1.2, 2.3, 2.5, 3.4 & 3.9 cm.; It was Ø.Ø, Ø.Ø, Ø.Ø, Ø.Ø, Ø.Ø4 & Ø.Ø8 cm.; It was Ø.Ø3, 1.2, 2.3, 3.4, 3.9, & 4.5 cm.; It was Ø.23, Ø.25, Ø.7, 1.5, 1.9, & 2.Ø cm.; It was 1.2, 2.Ø, 2.8, 3.Ø, 3.4, & 3.5 cm.; It was Ø.8, 1.Ø, 1.2, 1.9, 2.5 & 3.1 cm. and It was Ø.Ø3, Ø.5, 1.Ø, 1.5, 2.5 & 3.Ø cm. in culture media number 1, 2, 3, 4, 5, 6, 7, 8, 9, 1Ø, 11, 12, 13 (A), 13 (B) and 13 (C) after 4, 8, 12, 16, 2Ø and 24 hours of incubation period, respectively.

2 (B). EFECT OF DIFFERENT LIQUID CULTURE MEDIA ON THE GROWTH OF RHIZOPUS STOLONIFER (Ehrenb. ex. Fr.) Lind. :

The growth (mycelial dry weight) of the R. stolonifer was also observed on liquid culture media. It is clear from the Table No. (3); Fig. No. (2-b). That maximum mycelial dry weight was observed on Potato dextrose liquid medium and Malt extracts liquid medium while less mycelial dry weight was observed in Brown's liquid medium, and Czapek's-Dox liquid medium. The growth was absent in Richard's liquid medium.

The data in the table (3), Fig. (2-b) showed that the mycelial dry weight was Ø.1 (mg), Ø.Ø (mg), Ø.1 (mg), 9Ø.6 (mg), 5.3 (mg), 39.9 (mg), 36.6 (mg), 27.8 (mg), 48.Ø (mg), 16.5 (mg), 98.Ø (mg), 32.3 (mg), 58.2 (mg), 37.9

TABLE NO. 3 : EFFECT OF DIFFERENT LIQUID CULTURE MEDIA ON THE MYCELIAL GROWTH OF RHIZOPUS STOLONIFER :

S. No.	Culture Media	Mycelial dry weight of the pathogen (mg.)
1.	Brown's liquid medium	Ø.1
2.	Richard's liquid medium	Ø.Ø
3.	Czapek's Dox liquid medium	Ø.1
4.	Malt Extracts liquid medium	9Ø.6
5.	Ashthana & Hawker's liquid medium	5.3
6.	Martin's liquid medium	39.9
7.	Sabouraud's Dextrose liquid medium	36.6
8.	Corn meal liquid medium	27.8
9.	Riker and Riker liquid medium	48.Ø
1Ø.	Soyabean meal liquid medium	16.5
11.	Potato Dextrose liquid medium	98.Ø
12	Oat meal liquid medium	32.3
13.A	Host Extracts (scale meal) liquid medium	58.2
13.B	Host Extracts (seed meal) liquid medium	37.3
13.C	Host Extracts (pulp meal) liquid medium	42.Ø
	CD at 5%	6.31
	CD at 1%	8.86

Each reading is an average of three replicates.
Incubation temperature 3Ø C.
Incubation period 72 hours.

Fig. No. 2 (b) :- Effect of different liquid culture media on the mycelial growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind.

A = Brown's liquid medium

B = Richard's liquid medium

C = Czapek's Dox liquid medium

D = Malt extracts liquid medium

E = Asthana & Hawkers liquid medium

F = Martin's liquid medium

G = Sabouraud's Dextrose liquid medium

H = Corn meal liquid medium

I = Riker & Riker liquid medium

J = Soyabean meal liquid medium

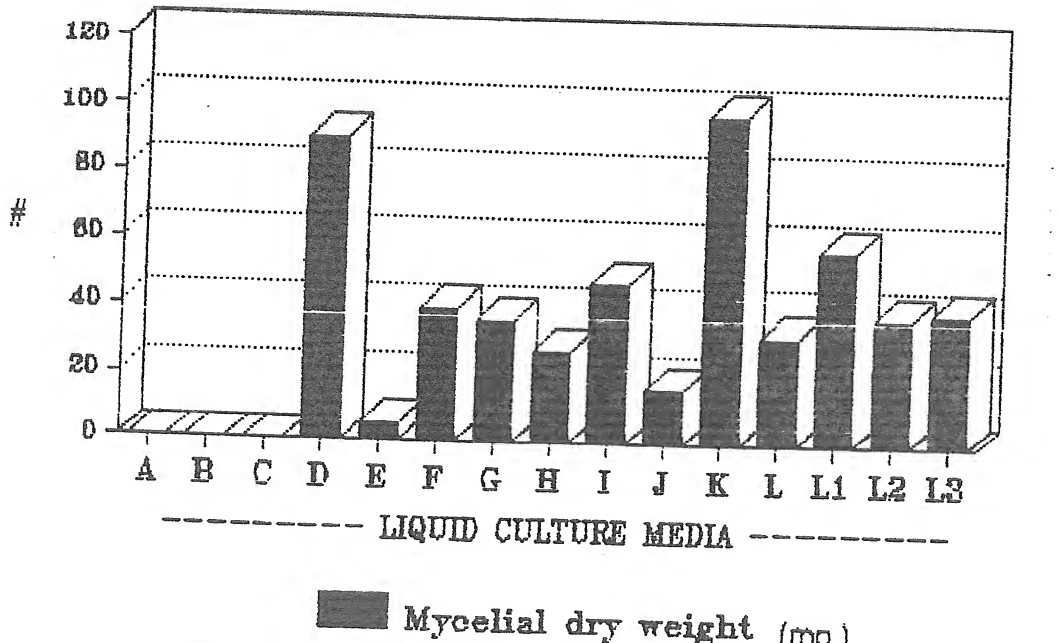
K = Potato Dextrose liquid medium

L = Oat meal liquid medium

L1 = Host extracts (scale) liquid medium

L2 = Host extracts (seed) liquid medium

L3 = Host extract (pulp) liquid medium



- MYCELIAL DRY WEIGHT OF THE PATHOGEN AFTER 72 HRS. (mg.)

Fig. No. 2(b)

(mg) and 40.0 (mg) in the liquid culture media number 1 to 13 (A, B & C) after 72 hours of incubation period, respectively.

3 (A). **EFFECT OF VARIOUS TEMPERATURES ON THE DEVELOPMENT OF SOFT-ROT IN PREMATURE JACK-FRUITS (IN VIVO) :**

The results of the experiments presented in Table No. (4); Plate No. (11-a); Fig. No. (3-a) exhibit that the temperature and incubation period plays an important role in the soft-rot development in jack-fruits. Results clearly showed that 30 °C, temperature was most favourable for the disease development in jack-fruits. At that temperature the fruit was completely rotted even at the incubation periods of 48 hours. At 0 °C, 5 °C, 10 °C no rotting was observed while at the 40 °C & 45 °C temperature the fungus was totally ineffective after 24 - 72 hours of incubation periods, respectively.

3 (B). **EFFECT OF VARIOUS TEMPERATURES ON THE GROWTH AND SPORULATION OF RHIZOPUS STOLONIFER (Ehrenb. ex. Fr.) Lind. (IN VITRO) :**

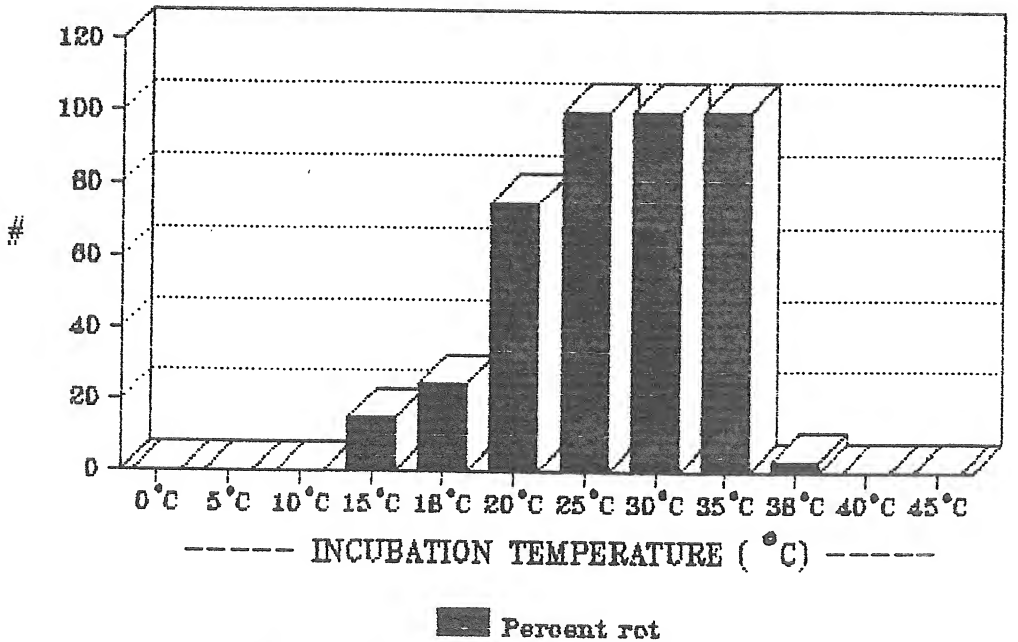
As is evident from the Table No. (5); Plate No. (11-b); Fig. No. (3-b) inoculation and subsequent incubation of petriplates (having potato dextrose agar medium) inoculated with test pathogen, R. stolonifer at different temperatures, resulted in the growth and

TABLE NO. 4 : EFFECT OF VARIOUS TEMPERATURES ON THE DEVELOPMENT OF SOFT-ROT IN PREMATUE JACK-FRUITS (ARTOCARPUS HETEROPHYLLUS LAMK.) INOCULATED WITH RHIZOPUS STOLONIFER (IN VIVO).

S. NO.	INCUBATION TEMPERATURE °C	APPEARANCE OF SYMPTOMS (Hrs.)	PERCENT ROTTING	AVERAGE LESION DIAM (cm.) Hrs.				DISEASE INTENSITY
				12	24	48	72	
1.	Ø	-	-	-	-	-	-	Nil
2.	5	-	-	-	-	-	-	Nil
3.	1Ø	-	-	-	-	-	-	Nil
4.	15	48	15.Ø	-	-	1.3	2.Ø	Slight
5.	18	24	25.Ø	-	2.Ø	2.5	3.Ø	Good
6.	2Ø	24	75.Ø	-	2.Ø	2.9	3.3	Moderate
7.	25	24	1ØØ.Ø	-	2.Ø	3.2	CFR	Severe
8.	3Ø	12	1ØØ.Ø	3.8	8.Ø	CFR	CFR	Severe
9.	35	24	1ØØ.Ø	1.8	2.6	3.9	CFR	Severe
1Ø.	38	24	35.Ø	-	1.9	2.2	2.9	Moderate
11.	4Ø	-	-	-	-	-	-	Nil
12.	45	-	-	-	-	-	-	Nil
13.	Control	-	-	-	-	-	-	-
	CD. at 5% level		1.13	Ø.32	Ø.47	Ø.44	Ø.2Ø	-
	CD. at 1% level		1.59	Ø.45	Ø.66	Ø.62	Ø.29	-

Note : Each reading is an average of three replicates.
CFR = Complete Fruit Rotten.
Rating Scale =
- : No Growth ; 1 - 2 : Slight ; 2 - 3 : Good ; 3 - 4 : Moderate, and above 4 : Severe.

Fig. No. 3 (a) :- Effect of various temperatures on the soft-rot development in Jack-fruits (Artocarpus heterophyllus Lamk.) inoculated with Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind., after 72 hours of incubation period (In Vivo).



- SOFT ROT DEVELOPMENT IN JACK - FRUITS

Fig. No. 3(a) **Incubation period 72 hrs.**

Plate No. 11 (a) :- Effect of various temperatures on the soft-rot development in premature Jack-fruits inoculated with soft-rot pathogen, Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. after 72, hours of incubation period. (In Vivo).

C = Control, which were kept with each cases separately.

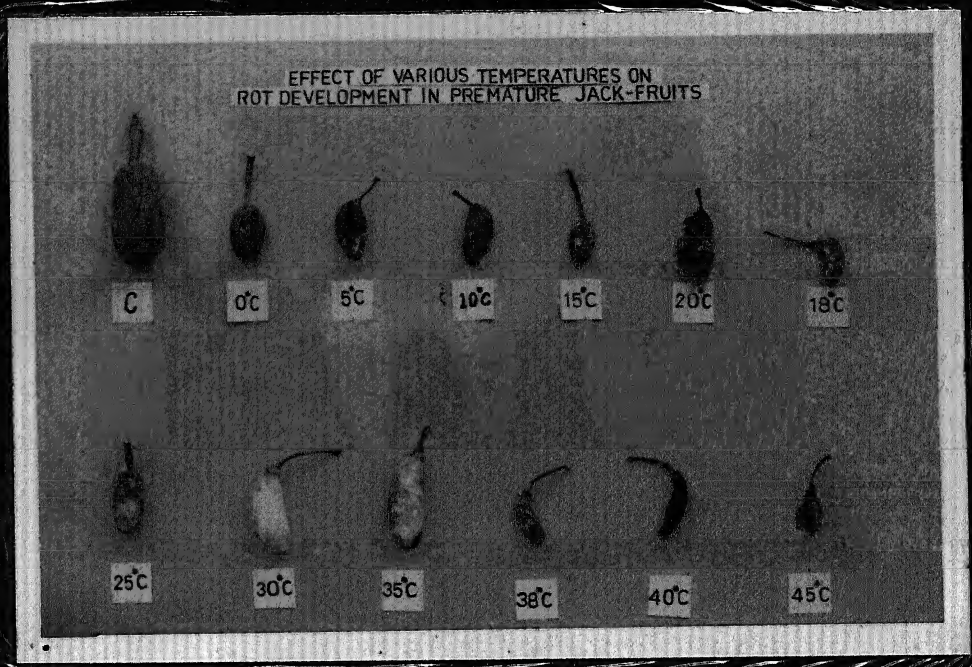

EFFECT OF VARIOUS TEMPERATURES ON
ROT DEVELOPMENT IN PREMATURE JACK-FRUITS
C
0°C
5°C
10°C
15°C
20°C
18°C
25°C
30°C
35°C
38°C
40°C
45°C

TABLE NO. 5 : EFFECT OF VARIOUS TEMPERATURES ON THE RATE MYCELIAL GROWTH AND SPORULATION STOLONIFER (IN VITRO). :

S. No.	INCUBATION TEMPERATURE (°C)	DIAMETER OF GROWTH (CM.) HOURS AFTER INCUBATION 4	12	24	48	72	SPORULATION
1.	Ø °C	-	-	-	-	-	Nil
2.	5 °C	-	-	-	-	-	Nil
3.	10°C	-	-	Ø.3	Ø.4	Ø.4	Nil
4.	15°C	-	Ø.4	1.6	1.7	1.99	Nil
5.	18°C	-	Ø.5	2.Ø	2.8	3.4	Poor
6.	2Ø°C	-	1.Ø	2.8	3.5	F	Good
7.	25°C	Ø.2	2.Ø	4.3	F	F	Good
8.	3Ø°C	2.7	3.Ø	F	F	F	Excellent
9.	35°C	1.8	2.9	4.4	F	F	Good
1Ø.	38°C	-	Ø.8	1.8	2.5	3.Ø	Poor
11.	4Ø°C	-	-	-	-	-	Nil
12.	45°C	-	-	-	-	-	Nil
CD. at 5% level		Ø.Ø6	Ø.2Ø	Ø.2Ø			
CD. at 1% level							

Note : Each re
F = Entire [illegible] was covered in each [illegible]

Fig. No. 3 (b) :- Effect of various temperatures on the growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. (In Vitro).

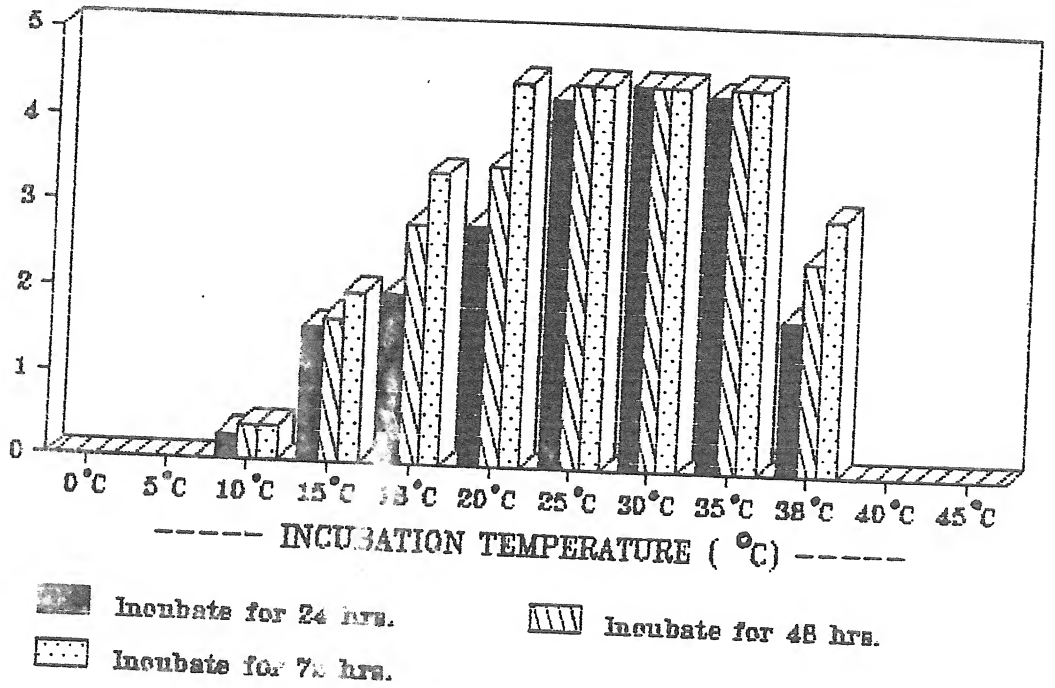
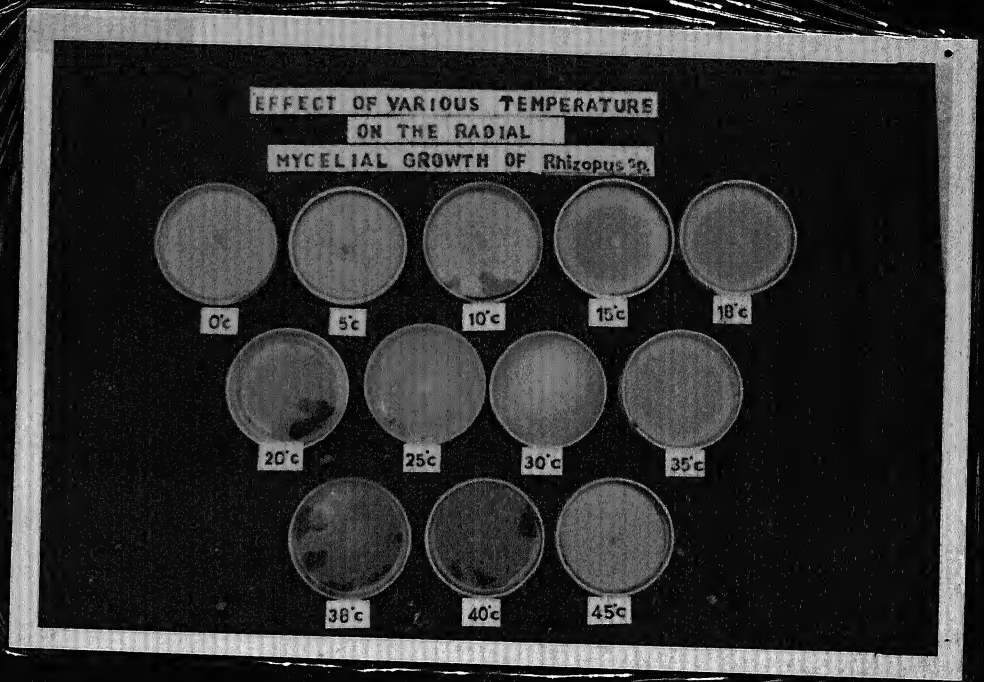


Fig. No. 3 (b) # - RADIAL MYCELIAL GROWTH (cm.)

Plate No. 11 (b) :- Effect of various temperatures on the radial mycelial growth and sporulation of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. In Vitro.


EFFECT OF VARIOUS TEMPERATURE
ON THE RADIAL
MYCELIAL GROWTH OF Rhizopus sp.
0°c
5°c
10°c
15°c
18°c
20°c
25°c
30°c
35°c
38°c
40°c
45°c

sporulation of R. stolonifer. Data were recorded in terms of radial mycelial growth and sporulation of the test pathogen.

It is clear from the results that 30°C caused maximum growth and sporulation of the test pathogen. Examination of the inoculated petriplates even at the short incubation period of 24 hour at 30°C revealed the optimum growth and sporulation of the R. stolonifer while at 0°C & 5°C no radial mycelial growth and sporulation was observed at the incubation period of 4, 12, 24, 48 and 72 hours, respectively. On the other hand 10°C 15°C, 18°C, 20°C, 25 °C, 30 °C and 35°C temperatures radial growth of the fungus was 0.4, 1.99, 3.4, 4.5 (F), 4.5 (F), 4.5 (F), 4.5 (F), 3.0 cm., respectively after 72 hours of incubation period. However there was no growth and sporulation was observed at 40°C & 45 °C temperatures.

At 30°C temperature maximum sporulation was occured while at 0°C, 5 °C, 40 °C & 45°C temperatures it was nil.

4. **THE STUDIES ON HOST RANGE OF THE SOFT-ROT PATHOGEN , RHIZOPUS STOLONIFER (Ehrenb. ex. Fr.) Lind. USING VARIOUS FRUITS AND VEGETABLES ARTIFICIALLY INOCULATED WITH THE TEST PATHOGEN :**

The results of the experiments to find out the

host range of R. stolonifer were carried out in the present investigation which revealed that soft-rot resulted in most of the fruits and vegetables tested as presented in the Table No. (6); Plate No. (12a-12i); Fig. No. (4a-4c). It is clear from the results that maximum percentage rotting was observed in Momordiaca charantia Linn. , Citrullus vulgaris var. Fistulosus Duth. & Full. Trichosanthes dioica Roxb., Coccinia indica Wt. & Arn. Cucumis sativus Linn., Solanum melongena Linn., Lycopersicon esculentum Mill., Capsicum sp. Linn., Carica papaya Linn., Abelmoschus esculentus (L.) Moench. followed by Luffa cylindrica (L.) Roem., Musa paradisiaca Linn. and Mangifera indica Linn., least percentage rotting was observed in Solanum tuberosum Linn., Pyrus malus Linn., Pyrus communis Linn., Citrus sinensis (L.) Osbeck., Citrus limon (L.) Burn. f., Allium cepa Linn., Emblica officinalis Gaertn., Punica granatum Linn., Carissa carandus Linn. and Raphanus sativus Linn., while nagative results of percentage rotting were showed by Allium sativum Linn., Calocasia antiquorum Linn. and Zingiber officinale Rosc. after 96 hours of incubation period, respectively.

As revealed by the data recorded in the table no.(6) percentage rotting was 23.14, 25.15, 100.0 (CFR) and 100.0 (CFR) in Momordica charantia; It was 10.15, 12.57, 24.00 and 100.0 (CFR) in Luffa cylindrica; It was 13.98,

TABLE NO. 6 : HOST RANGE OF SOFT-ROT PATHOGEN, RHIZOPUS STOLONIFER USING VARIOUS FRUITS AND VEGETABLES ARTIFICIALLY INOCULATED WITH THE TEST PATHOGEN :

S. No.	Botanical Name	Percent rot Incubation period (hrs.)				Extent of rotting
		24	48	72	96	
1.	Momordica Charantia linn.	23.14	25.15	CFR	CFR	+++
2.	Luffa cylindrica (L.) Roem.	10.15	12.57	24.08	CFR	++
3.	Citrullus vulgaris var. fistulosus Duth. & Full.	13.98	48.31	CFR	CFR	+++
4.	Trichosanthes dioica Roxb.	25.75	63.04	CFR	CFR	+++
5.	Coccinia indica Wt. Arn.	66.15	CFR	CFR	CFR	+++
6.	Cucumis sativus Linn.	32.82	CFR	CFR	CFR	+++
7.	Solanum tuberosum Linn.	2.35	8.95	27.55	39.31	+
8.	Solanum melongena Linn.	19.13	CFR	CFR	CFR	+++
9.	Lycopersicon esculentum Mill.	22.75	55.30	CFR	CFR	+++
10.	Capsicum sp. Linn.	24.56	CFR	CFR	CFR	+++
11.	Pyrus malus Linn.	11.99	32.58	43.41	44.01	+
12.	Pyrus communis Linn.	27.5	36.37	59.93	63.93	+
13.	Citrus sinensis (L.) Osbeck.	0.00	1.97	3.56	3.78	+
14.	Citrus limon (L.) Burn. f.	7.97	8.39	8.47	29.16	+
15.	Allium cepa Linn.	0.00	0.00	0.50	1.76	+
16.	Allium sativum Linn.	0.00	0.00	0.00	0.00	-
17.	Emblica officinalis Gaertn.	0.00	1.07	6.80	14.10	+
18.	Punica granatum Linn.	1.76	6.78	10.80	16.30	+

Contd.

19.	Musa paradisiaca Linn.	7.77	16.43	38.64	CFR	++
20.	Carissa carandus Linn.	11.99	27.10	28.72	66.9	+
21.	Carica papaya Linn.	49.18	CFR	CFR	CFR	+++
22.	Calocasia antiquorum Linn.	0.00	0.00	0.00	0.00	-
23.	Zingiber officinale Rosc.	0.00	0.00	0.05	1.00	-
24.	Raphanus sativus Linn.	0.00	0.00	0.00	1.98	+
25.	Abelmoschus esculentus (L.) Moench.	7.25	55.79	CFR	CFR	+++
26.	Mangifera indica Linn.	9.0	31.21	69.66	CFR	++
	CD at 5% level	1.83	3.98	5.15	4.34	-
	CD at 1% level	2.57	5.59	7.23	6.10	-

Each reading is an average of three replicates.
Inoculated fruits & vegetables were incubated at 30 C temperature and 100% relative humidity.
Percent rot was calculated as described by Gaur and Chenulu (1982).
Extent of rotting were recorded by the following scale :
- : Resistent ; + : Less susceptible ; ++ : Moderate susceptible;
+++ : Highly susceptible.
CFR; Complete fruit rotten.

Fig. No. 4 (a) :- Host range of soft-rot pathogen, Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind., using fruit and vegetables, artificially inoculated with the test pathogen.

A = Momordica charantia Linn.

B = Luffa cylindrica (L.) Roem.

C = Citrullus vulgaris var. fistulosus Duth. & Full.

D = Trichosanthes dioica Roxb.

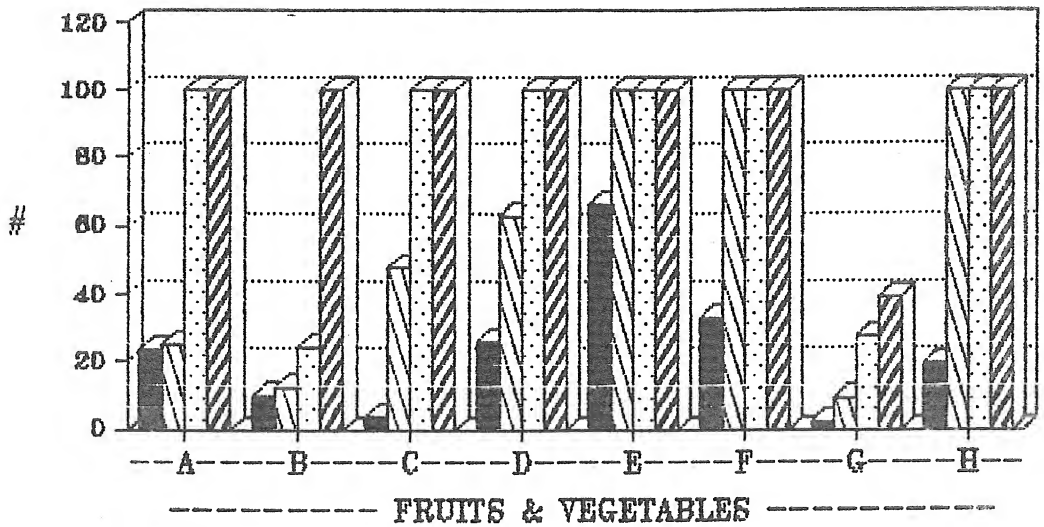
E = Coccinia indica Wt. Arn.

F = Cucumis sativus Linn.

G = Solanum tuberosum Linn.

H = Solanum melongena Linn.

HOST RANGE OF SOFT-ROT PATHOGEN



- PERCENT ROT

Fig. No. 4(a)

Fig. No. 4 (b) :- Host range of soft-rot pathogen, Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind., using fruit and vegetables, artificially inoculated with the test pathogen.

I = Lycopersicon esculentum Mill.

J = Capsicum sp.

K = Pyrus malus Linn.

L = Pyrus communis Linn.

M = Citrus sinensis (L.) Osbeck.

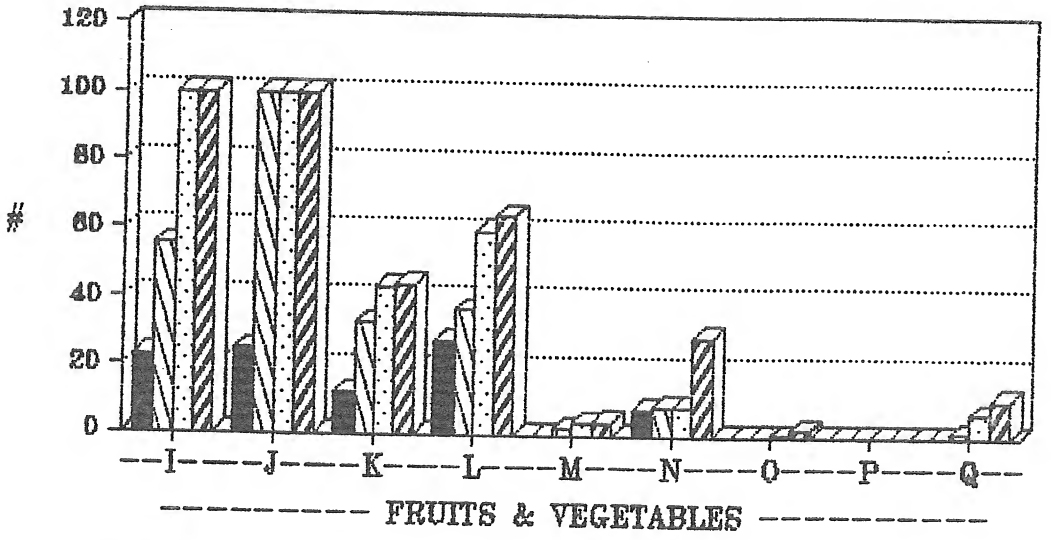
N = Citrus limon (L.) Burn. f.

O = Allium cepa Linn.

P = Allium sativun Linn.

Q = Emblica officinalis Gaertn.

HOST RANGE OF SOFT-ROT PATHOGEN



- PERCENT ROT

Fig. No. 4(b)

Fig. No. 4 (c) :- Host range of soft-rot pathogen, Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind., using fruit and vegetables, artificially inoculated with the test pathogen.

R = Punica granatum Linn.

S = Musa paradisiaca Linn.

T = Carissa carandus Linn.

U = Carica papaya Linn.

V = Calocasia antiquorum Linn.

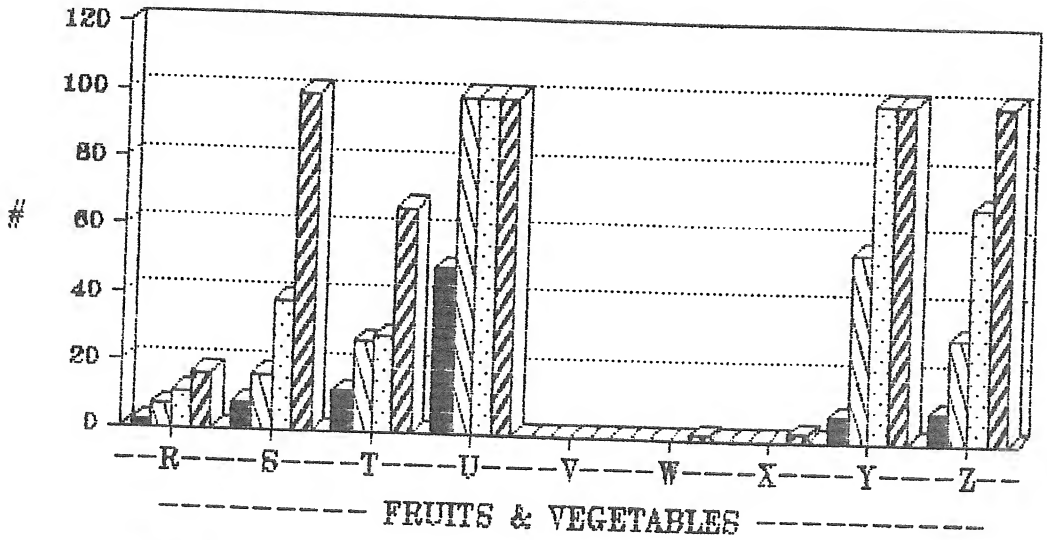
W = Zingiber officinale Rosc.

X = Raphanus sativus Linn.

Y = Abelmoschus esculentus (L.) Moench.

Z = Mangifera indica Linn.

HOST RANGE OF SOFT-ROT PATHOGEN



- PERCENT ROT

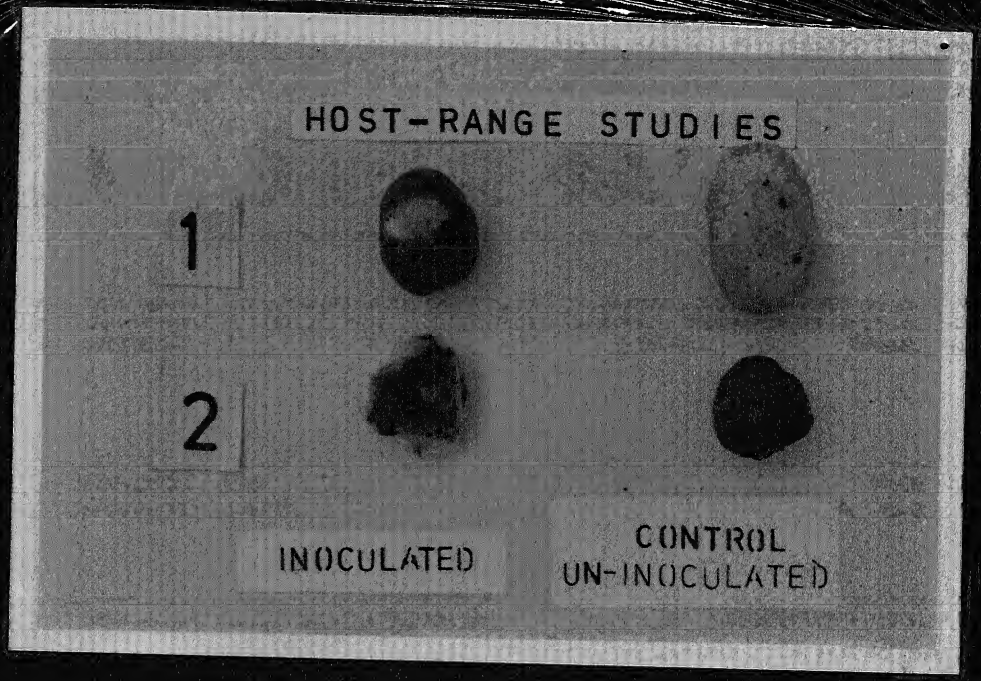
Fig. No. 4(c)

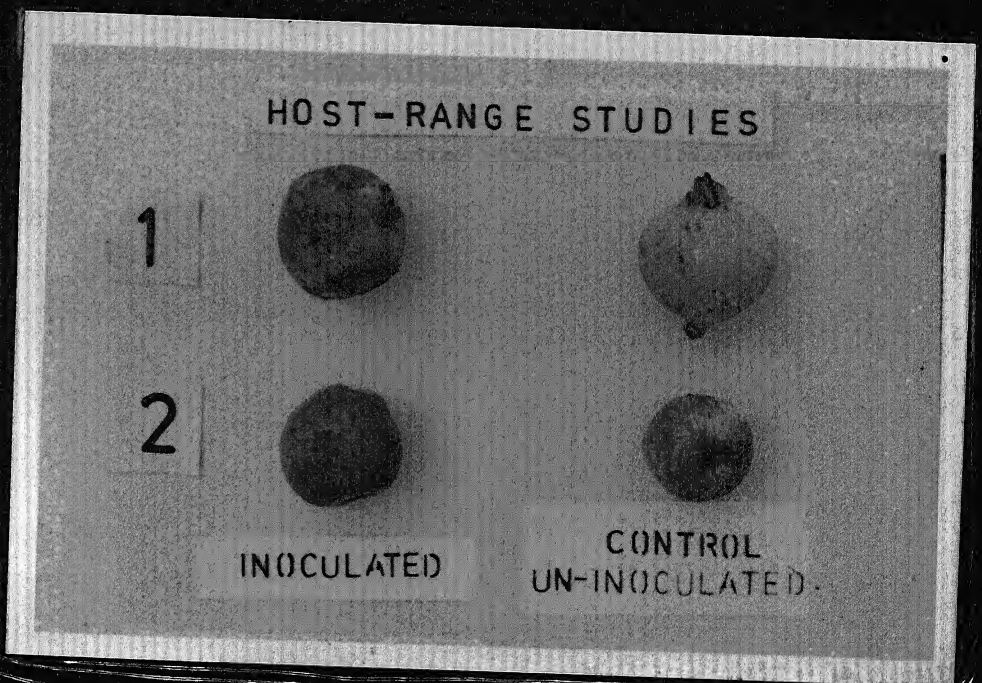
Plate No. 12 (a) :- Host range studies of soft-rot pathogen Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. when inoculated on -

1. Solanum tuberosum Linn.
2. Capsicum sp..

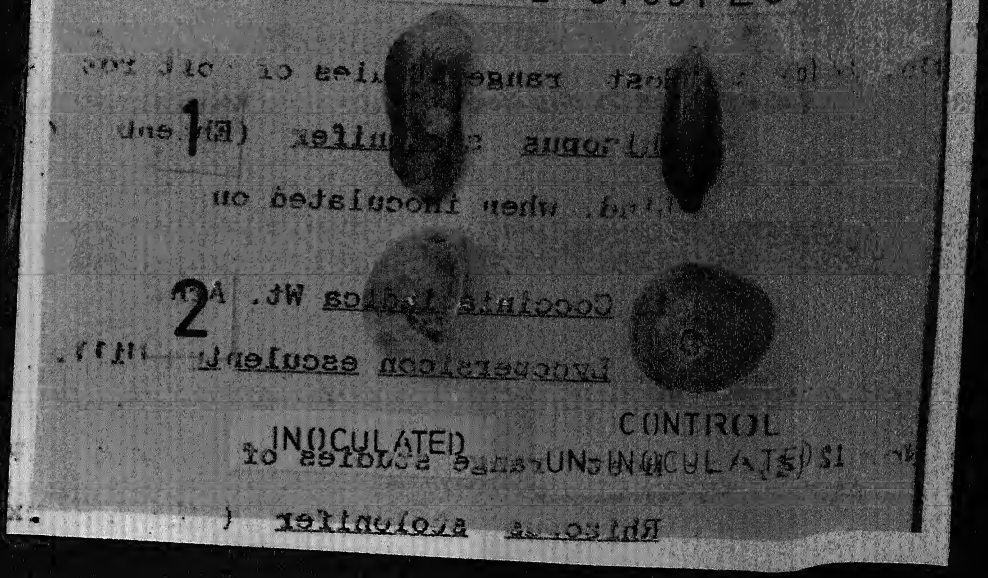
Plate No. 12 (b) :- Host range studies of soft-rot pathogen Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. when inoculated on -

1. Punica granatum Linn.
2. Pyrus malus Linn.


HOST-RANGE STUDIES
1
2
INOCULATED
CONTROL
UN-INOCULATED


HOST-RANGE STUDIES
1
2
INOCULATED
CONTROL
UN-INOCULATED

HOST-RANGE STUDIES



HOST-RANGE STUDIES

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INOCULATED

CONTROL
UN-INOCULATED

HOST-RANGE STUDIES

1

2

INOCULATED

CONTROL
UN-INOCULATED

Plate No. 12 (e) :- Host range studies of soft-rot pathogen Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. when inoculated on -

1. Allium sativum Linn.
2. Zingiber officinale Rosc.

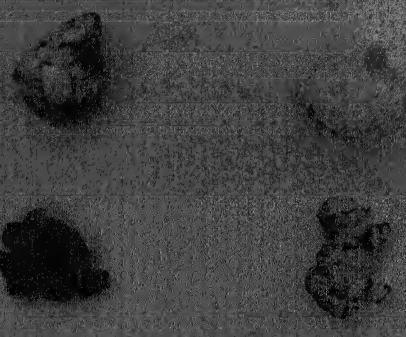
Plate No. 12 (f) :- Host range studies of soft-rot pathogen Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. when inoculated on -

1. Carissa carandus Linn.

HOST-RANGE STUDIES

1

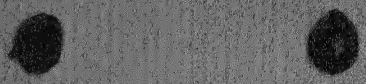
2



INOCULATED

CONTROL
UN-INOCULATED

HOST-RANGE STUDIES



INOCULATED

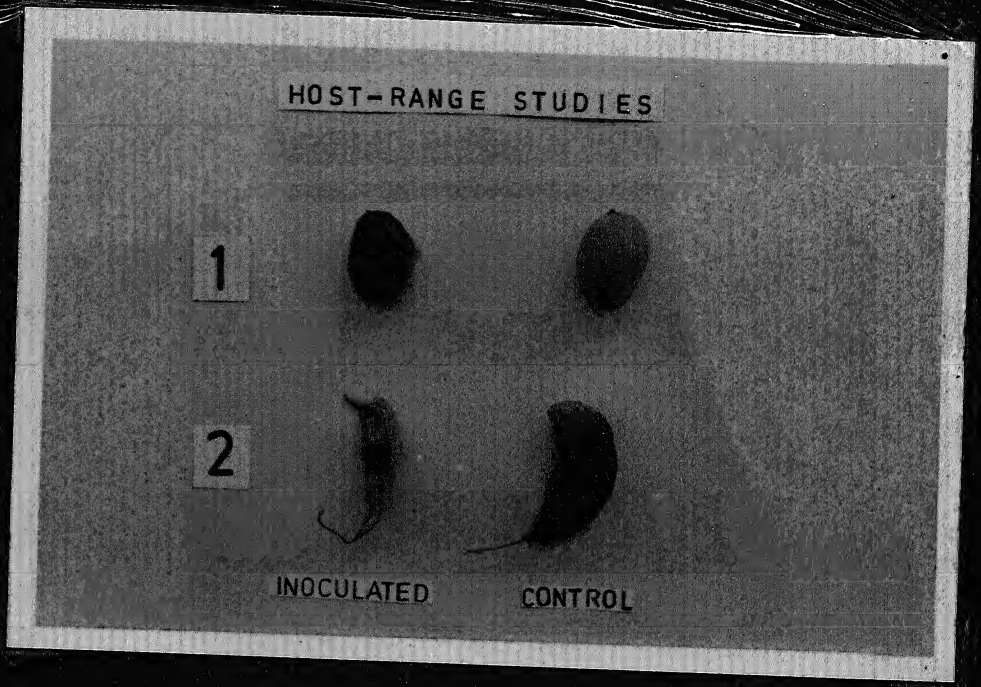
CONTROL
UN-INOCULATED

Plate No. 12 (g) :- Host range studies of soft-rot pathogen Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. when inoculated on -

1. Mangifera indica Linn.
2. Momordica charantia Linn.

Plate No. 12 (h) :- Host range studies of soft-rot pathogen Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. when inoculated on -

1. Citrus sinensis (L.) Osbeck.
2. Allium cepa Linn.


HOST-RANGE STUDIES
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2
INOCULATED
CONTROL

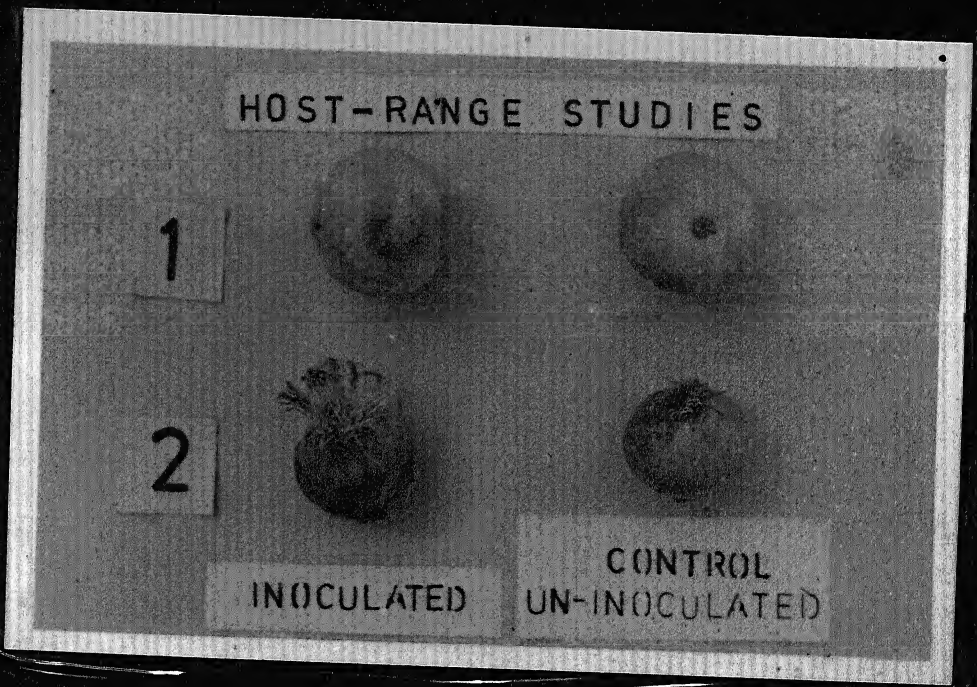
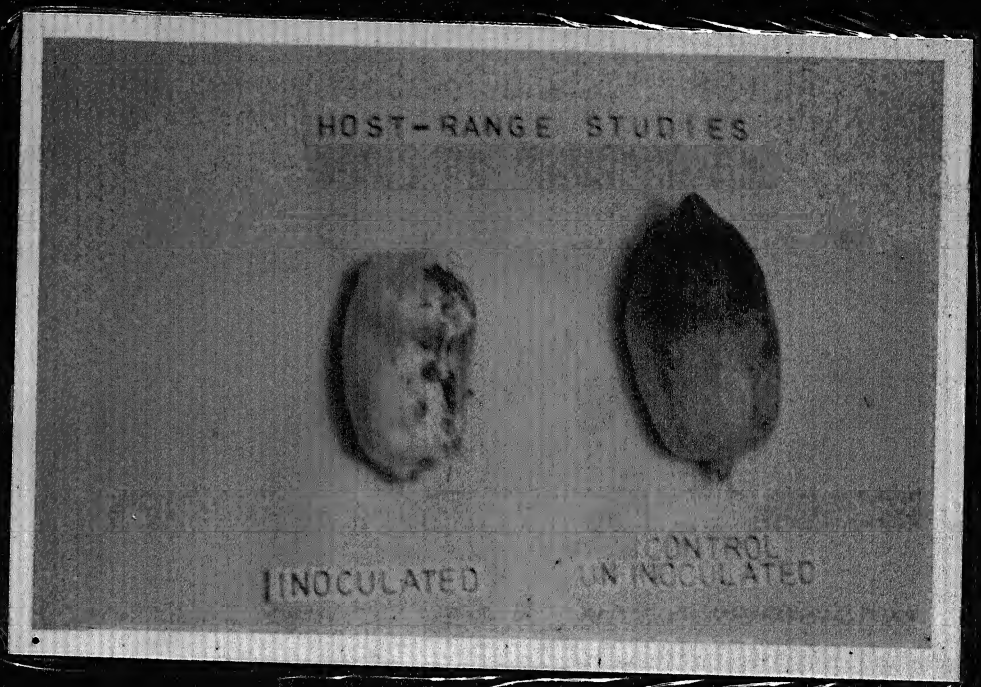

HOST-RANGE STUDIES
1
2
INOCULATED
CONTROL
UN-INOCULATED

Plate No. 12 (i) :- Host range studies of soft-rot pathogen Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. when inoculated on -

1. Carica papaya Linn.


HOST-RANGE STUDIES
INOCULATED
CONTROL
UNINOCULATED

48.31, 100.0 (CFR) and 100.0 (CFR) in Citrullus vulgaris; It was 25.75, 63.04, 100.0 (CFR) and 100.0 (CFR) in Trichosanthes dioica; It was 66.15, 100.0 (CFR), 100.0 (CFR) and 100.0 (CFR) in Coccinia indica; It was 32.82, 100.0 (CFR), 100.0 (CFR) and 100.0 (CFR) in Cucumis sativus; It was 2.35, 8.95, 27.55 and 39.31 in Solanum tuberosum; It was 19.13, 100.0 (CFR), 100.0 (CFR) and 100.0 (CFR) in Solanum melongena; It was 22.75, 55.30, 100.0 (CFR) and 100.0 (CFR) in Lycopersicon esculentum; It was 24.56, 100.0 (CFR), 100.0 (CFR) and 100.0 (CFR) in Capsicum sp.; It was 11.99, 32.58, 43.41 and 44.01 in Pyrus malus; It was 27.5, 36.37, 59.93 and 63.93 in Pyrus communis; It was 0.00, 1.97, 3.56, and 3.78 in Citrus sinensis; It was 7.97, 8.39, 8.47 and 29.16 in Citrus limon; It was 0.00, 0.00, 0.50 and 1.76 in Allium Cepa; It was 0.00, 0.00,0.00 and 0.00 in Allium sativum; It was 0.00, 1.07, 6.80, and 11.10 in Emblica officinalis; It was 1.76, 6.78, 10.80, and 16.30 in Punica granatum; It was 7.77, 16.43, 38.64 and 100.0(CFR) in Musa paradisiaca; It was 11.99, 27.10, 28.72 and 66.9 in Carissa carandus; It was 49.18, 100.0 (CFR), 100.0 (CFR) and 100.0 (CFR) in Carica papaya; It was 0.00, 0.00, 0.00 and 0.00 in Calocasia antiquorum; It was 0.00, 0.00, 0.00 and 0.00 it Zingiber officinale; It was 0.00, 0.00, 0.00 and 1.98 in Raphanus sativus 7.25, 55.79, 100.0 (CFR) and 100.0 (CFR) in Abelmoschus esculentus it was 9.0, 31.21, 69.66 & 100.0 (CFR) in Mangifera indica after 24,

48, 72 and 96 hours of incubation period, respectively.

5. **INHIBITORY EFFECT OF PRE & POST-DIP TREATMENTS OF CULTURAL FILTRATES OF VARIOUS FUNGAL ORGANISMS ON THE DEVELOPMENT OF SOFT-ROT IN PREMATURE JACK-FRUITS WHEN ARTIFICIALLY INOCULATED WITH SOFT-ROT PATHOGEN, RHIZOPUS STOLONIFER** (Ehrenb. ex. Fr.) Lind. (IN VIVO) :

The results of the experiments on the evaluation of the cultural filtrates of various fungal organisms isolated from the soil adjacent to jack-fruit trees on the development of soft-rot pathogen, R. stolonifer in premature jack-fruits as revealed by the data recorded in the Table No. (7a-7b); Plate No. (13a-13b); Fig. No. (5a-5b) showed that all the cultural filtrates of test fungi (except cultural filtrates number 2,3, 8,9 & 1Ø) could check the disease development on premature jack-fruits caused by R. stolonifer at different incubation periods. It is clear from the results that the treatments with the culture filtrate of Aspergillus niger was most effective (calculated as stated on page no.-) in checking the soft-rot development followed by Chaetomium sp. in both pre and post-dip treatments after 72 hours of incubation period, respectively. There was no inhibition with cultural filtrates of Fusarium sp., Alternaria sp., Curvularia sp. , Helminthosporium tetramera and Aspergillus flavus in both pre and post-dip treatments

TABLE 7 (A) : INHIBITORY EFFECT OF PRE-DIP TREATMENTS OF CULTURAL FILTRATES OF VARIOUS FUNGAL ORGANISMS ON THE DEVELOPMENT OF SOFT-ROT IN PREMATURE JACK FRUITS WHEN ARTIFICIALLY INOCULATED WITH SOFT-ROT PATHOGEN, RHIZOPUS STOLONIFER (IN VIVO) :

S. No.	TREATMENTS (Spore with mycelial suspension of fungal organisms)	PERCENT SOFT-ROT (Hours)			PERCENT INHIBITION OVER CONTROL
		24	48	72	
1.	Aspergillus niger	Ø.Ø	2Ø.Ø*	26.66*	73.34*
2.	Fusarium sp.	3Ø.Ø	33.33*	CFR	Ø.ØØ
3.	Alternaria sp.	29.62	37.Ø3*	CFR	Ø.ØØ
4.	Cladosporium sp.	32.43	35.13*	4Ø.54*	59.46
5.	Nigrospora sp.	2Ø.Ø*	33.33*	4Ø.Ø*	6Ø.Ø
6.	Chaetomium sp.	1Ø.Ø*	25.Ø*	34.78*	65.22*
7.	Stylopage sp.	Ø.Ø	13.Ø4*	4Ø.Ø*	6Ø.Ø*
8.	Curvularia sp.	Ø.Ø	2Ø.Ø*	CFR	Ø.ØØ
9.	Helminthosporium tetramera	Ø.Ø	11.11*	CFR	Ø.ØØ
1Ø.	Aspergillus flavus	Ø.Ø	9.Ø7*	CFR	Ø.ØØ
11.	Control	25.92	CFR	CFR	-
	CD. at 5% level	1.58	2.49	2.45	-
	CD. at 1% level	2.22	3.5Ø	3.45	-

Note :- Each reading is an average of three replicates
Inoculated fruits were incubated at 3Ø C temperature and 1ØØ% R.H.
CFR = Complete Fruit Rotten.
* = Significant at 1% level against untreated.

Fig. No. 5 (a) :- Inhibitory effect of pre-dip treatments of cultural filtrates of various fungal organisms on the development of soft-rot in premature Jack-fruits (Artocarpus heterophyllus Lamk.) when artificially inoculated with soft-rot pathogen, Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind.

A = Aspergillus niger

B = Fusarium sp.

C = Alternaria sp.

D = Cladosporium sp.

E = Nigrospora sp.

F = Chaetomium sp.

G = Stylopage sp.

H = Curvularia sp.

I = Helminthosporium tetramera

J = Aspergillus flavus

Control (untreated).

PRE-DIP TREATMENTS OF CULTURAL FILTRATES
ON THE SOFT-ROT DEVELOPMENT

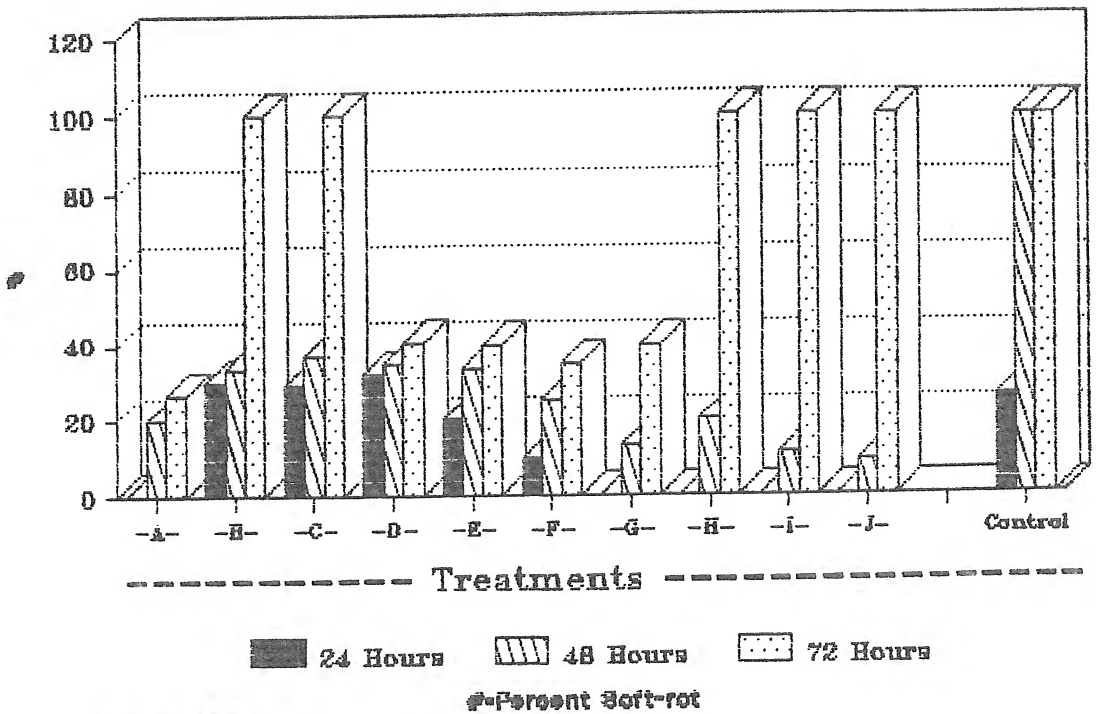
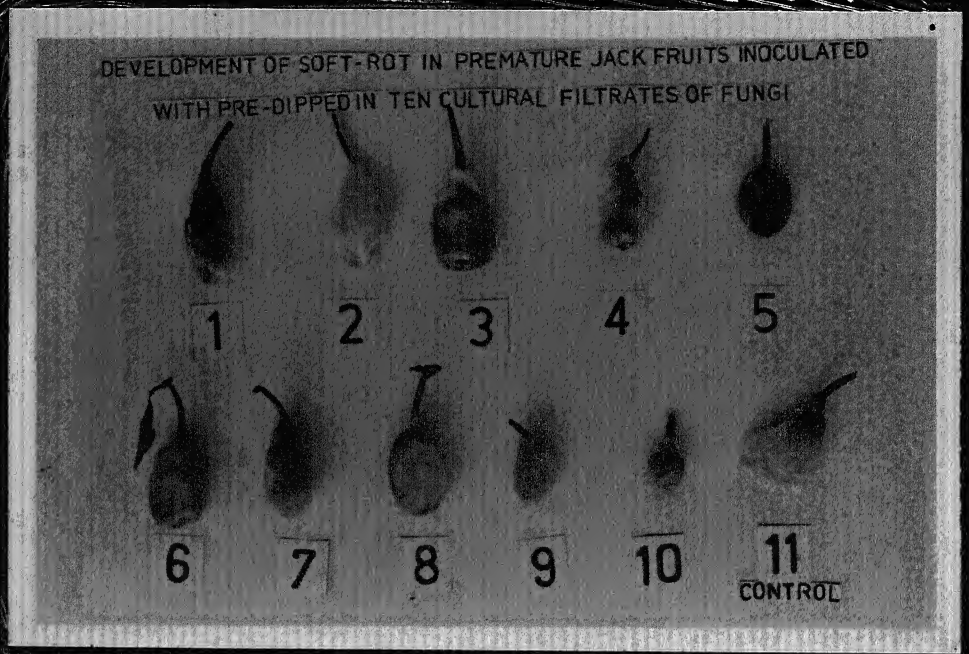


Fig. No. 6(a)

Plate No. 13 (a) :-

Inhibitory effect of pre-dip treatments of cultural filtrates of ten fungi on the soft-rot development in premature Jack-fruits artificially inoculated with soft-rot pathogen, Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind.

1. Aspergillus niger
2. Fusarium sp.
3. Alternaria sp.
4. Cladosporium sp.
5. Trichospora sp.
6. Chaetomium sp.
7. Botrytis sp.
8. Curvularia sp.
9. Helminthosporium tetramera
10. Aspergillus flavus
11. Control (untreated)


DEVELOPMENT OF SOFT-ROT IN PREMATURE JACK FRUITS INOCULATED
WITH PRE-DIPPED IN TEN CULTURAL FILTRATES OF FUNGI
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CONTROL

TABLE 7 (B) : INHIBITORY EFFECT OF POST-DIP TREATMENTS OF CULTURAL FILTRATES OF VARIOUS FUNGAL ORGANISMS ON THE DEVELOPMENT OF SOFT-ROT IN PREMATURE JACK FRUITS WHEN ARTIFICIALLY INOCULATED WITH SOFT-ROT PATHOGEN, RHIZOPUS STOLONIFER (IN VIVO) :

S. No.	TREATMENTS (Spore with mycelial suspension of fungal organisms)	PERCENT SOFT-ROT (Hours)			PERCENTAGE INHIBITION OVER CONTROL
		24	48	72	
1.	Aspergillus niger	Ø.ØØ	18.75*	47.21*	52.79*
2.	Fusarium sp.	29.41*	35.47*	CFR	70.00*
3.	Alternaria sp.	17.39*	36.40*	CFR	70.00*
4.	Cladosporium sp.	2Ø.83*	35.Ø4*	53.91*	46.09
5.	Nigrospora sp.	38.6*	44.44*	52.4Ø*	47.6
6.	Chaetomium sp.	31.11*	44.74*	5Ø.12*	49.88
7.	Stylopage sp.	Ø.ØØ	47.73*	52.Ø8*	47.92
8.	Curvularia sp.	17.37*	27.39*	CFR	7Ø.ØØ
9.	Helminthosporium tetramera	Ø.ØØ	11.76*	CFR	7Ø.ØØ
1Ø.	Aspergillus flavus	5.Ø7*	7.5Ø*	CFR	7Ø.ØØ
11.	Control	39.39	CFR	CFR	-
	CD. at 5% level	1.2Ø	2.25	2.Ø1	-
	CD. at 1% level	1.69	3.16	2.32	-

Note :- Each reading is an average of three replications
Inoculated fruits were incubated at 3Ø C temperature and
CFR = Complete Fruit Rotten.
* = Significant at 1% level against untreated.

Fig. No. 5 (b) :- Inhibitory effect of post-dip treatments of cultural filtrates of various fungal organisms on the development of soft-rot in premature Jack-fruits (*Artocarpus heterophyllus* Lamk.) when artificially inoculated with soft-rot pathogen, *Rhizopus stolonifer* (Ehrenb. ex. Fr.) Lind.

A = *Aspergillus niger*

B = *Fusarium sp.*

C = *Alternaria sp.*

D = *Cladosporium sp.*

E = *Nigrospora sp.*

F = *Chaetomium sp.*

G = *Stylopage sp.*

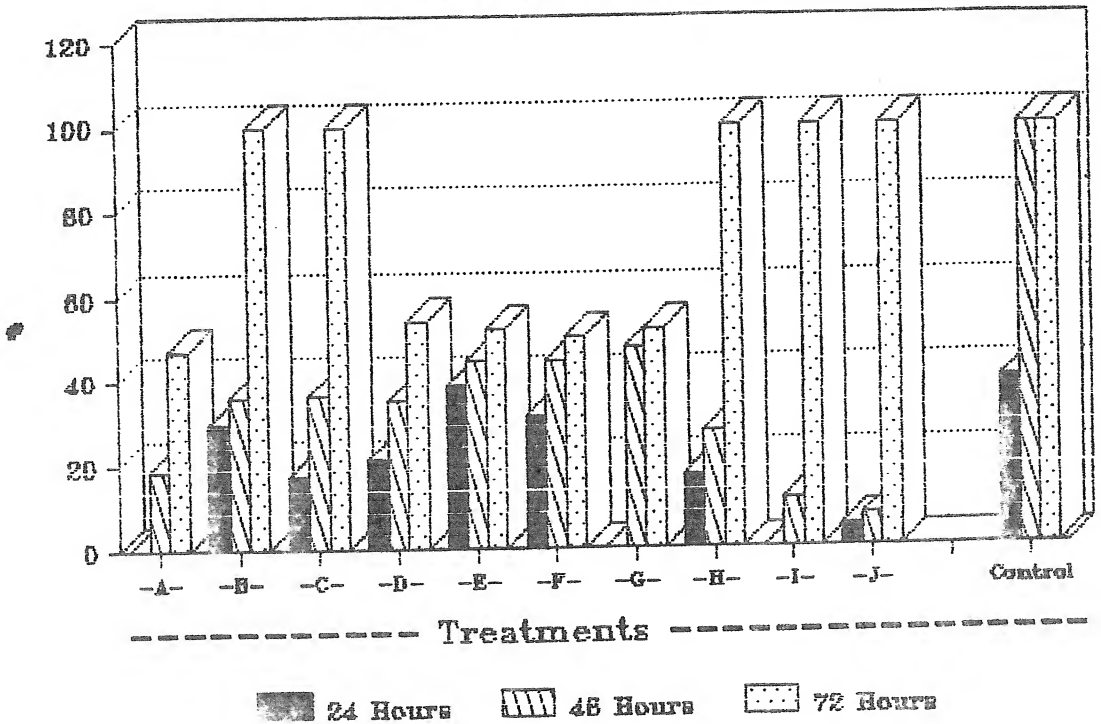
H = *Curvularia sp.*

I = *Helminthosporium tetramera*

J = *Aspergillus flavus*

Control (untreated).

POST-DIP TREATMENTS OF CULTURAL FILTRATES ON THE SOFT-ROT DEVELOPMENT



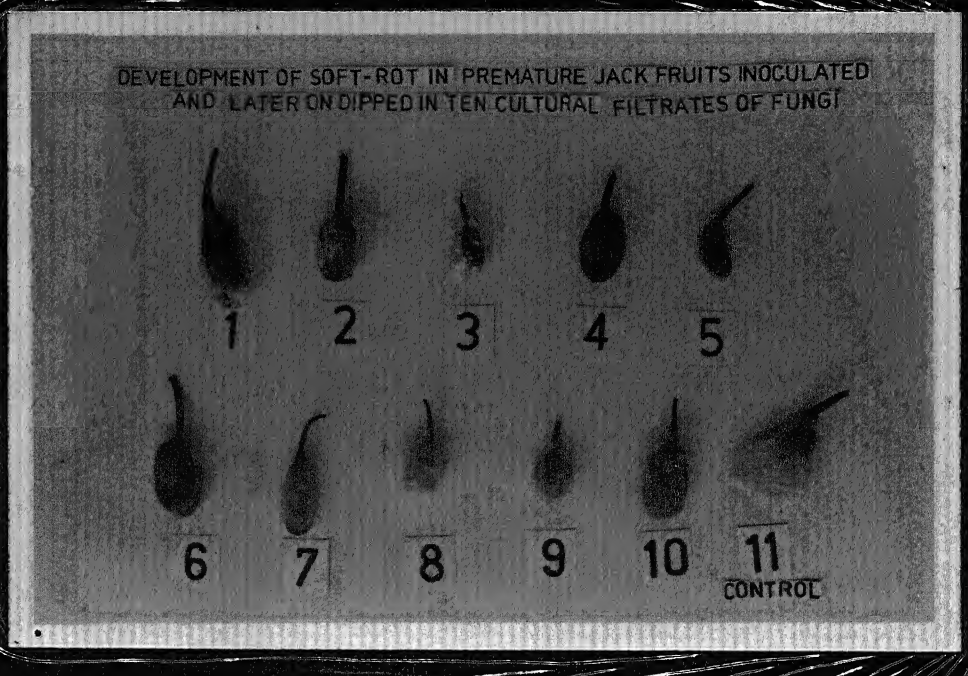
#=Percent Soft-rot

Fig. No. 6 (b)

Plate No. 13 (b) :-

Inhibitory effect of post-dip treatments of cultural filtrates of ten fungi on the soft-rot development in premature Jack-fruits artificially inoculated with soft-rot pathogen, Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind.

1. Aspergillus niger
2. Fuisarium sp.
3. Alternaria sp.
4. Cladosporium sp.
5. Nigrospora sp.
6. Chaetomium sp.
7. Stylopage sp.
8. Curvularia sp.
9. Helminthosporium tetramera
10. Aspergillus flavus
11. Control (untreated)


DEVELOPMENT OF SOFT-ROT IN PREMATURE JACK FRUITS INOCULATED AND LATER ON DIPPED IN TEN CULTURAL FILTRATES OF FUNGI
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CONTROL

after 72 hours of incubation period, respectively. The experimental data showed that the pre-dip treatments could check more disease development than the post-dip treatments.

The data presented in the table on the percent inhibition of cultural filtrates over control was 73.34% and 52.79% with the cultural filtrates of Aspergillus niger. The inhibition was Ø.Ø% (nil) and Ø.Ø% (nil) with the culture filtrates of Fusarium sp; It was Ø.Ø% (nil) and Ø.Ø% (nil) with the culture filtrates of Alterneria sp.; It was 59.46% and 46.Ø9% with the culture filtrates of Cladosporium sp ; It was 6Ø.Ø% and 47.6% with the culture filtrate of Nigrospora sp.. The inhibition was 65.22% and 49.86% with the culture filtrates of Chaetomium sp.; It was 6Ø.Ø% and 47.92% with the culture filtrates of Stylopage sp; It was Ø.Ø (nil) and Ø.Ø% (nil) with the culture filtrates of Curvularia sp; It was Ø.Ø (nil) and Ø.Ø (nil) with the culture filtrates of Helminthosporium tetramera and it was Ø.Ø% (nil) & Ø.Ø% (nil) with the culture filtrates of Aspergillus flavus when all the cultural filtrates treated as pre-dip inoculation treatments and post-dip inoculation treatments after 72 hours of incubation period, respectively.

6. EFFECT OF WATER SOLUBLE EXTRACTS OF SOME PLANTS ON THE GROWTH OF RHIZOPUS STOLONIFER (Ehrenb. ex. Fr.) Lind. (IN VITRO) :

The results of the experiments on the evaluation of the water soluble extracts of seventeen plants known for their antifungal activity on the radial mycelial growth of the R. stolonifer were recorded in Table No. (8); Plate No.(14a-14i); Fig. No. (6a-6b). Very significant growth inhibition (calculated as stated on page no.- 37) was observed in leaves extracts of Allium sativum Linn. (95.55%), Ocimum sanctum Linn. (80.0%), Clerodendron phlolytis Linn. (75.5%), Azadirachta indica A. Juss. (64.44%) and Lantana indica Roxb. (57.7%) the extracts obtained from the bulb of Allium sativum Linn. (100.0%), rhizome extracts Zingiber officinale Rosc. (100.0%). The moderate growth inhibition was observed in leaf extracts of Adhatoda vasica Nees. (48.0%), Jatropha gossipifolia Linn. (20.0%), Parthenium hysterophorus Linn. (31.11%), Allium cepa Linn. (bulbs-part, 28.88%) and leaf extracts of Launea asplenifolia Hook. f. Calotropis procera (Ait.) R., Barleria prionitis Linn. showed less mycelial growth inhibition. While in the leaf extracts of Allium cepa Linn. mycelial growth inhibition was nil at all concentrations viz., 25.0% (S1), 50.0% (S2), 75.0% (S3) and 100.0% (S4) after 72 hours of incubation

period, respectively.

The data presented in the table (8) revealed that percent inhibition was Ø.Ø%, 11.11%, 26.66%, and 57.77% in leaf extracts of Lantana indica Roxb.; It was Ø.Ø%, Ø.Ø%, Ø.Ø% and 15.55% in Launea asplenifolia Hook f.; It was Ø.Ø%, Ø.Ø%, Ø.Ø%, and 48.88% in Adhatoda vasica Nees.; It was Ø.Ø%, Ø.Ø%, Ø.Ø% and 11.11% in Calotropis procera (Ait.) R.; It was Ø.Ø%, Ø.Ø%, Ø.Ø% and 15.55% in Solanum xanthocarpum Linn.; It was Ø.Ø%, Ø.Ø%, Ø.Ø%, and 2Ø.Ø% in Jatropha gossipifolia Linn.; It was Ø.ØØ%, Ø.ØØ%, Ø.ØØ% and 11.11% in Barleria prionitis Linn.; It was Ø.ØØ%, Ø.ØØ% , 11.11% and 31.11%, in Parthenium hysterophorus Linn.; It was 22.22%, 4Ø.Ø% 51.11% and 64.44% in Azadirachta indica A. Juss.; It was 8.88%, 24.44%, 35.55% and 6Ø.Ø% in Clerodendron phlolytis Linn.; It was 4.44%, 15.55%, 22.22% and 75.55% in Catharanthus roseus G. Don.; It was 31.11%, 44.44%, 55.55% and 8Ø.Ø% in Ocimum sanctum Linn.; It was 11.11%, 17.77%, 33.33% and 95.55% in Allium sativum Linn.; It was Ø.Ø%, Ø.Ø%, 4.44% and 28.88% in bulbs of Allium cepa Linn.; It was 1ØØ.Ø%, 1ØØ.Ø%, 1ØØ.Ø%, and 1ØØ.Ø% in bulbs of Allium sativum Linn.; it was 1ØØ%, 1ØØ%, 1ØØ%, and 1ØØ% in the rhizomes of Zingiber officinale Rosc.; It was Ø.Ø%, Ø.Ø%, Ø.Ø% and Ø.Ø% in leaves of Allium cepa Linn. at in all concentration 25.Ø% (S1), 5Ø.Ø% (S2), 75.Ø% (S3) and 1ØØ.Ø% (S4) after 72 hours of incubation

TABLE NO. 8 : EFFECT OF WATER SOLUBLE PLANT EXTRACTS ON THE RADIAL MYCELIAL GROWTH OF RHIZOPUS STOLONIFER (IN VITRO). :

S. No.	Plant texa	Plant Parts	Concentration of extracts (%)							
			S1		S2		S3		S4	
			Radial mycelial growth (cm)	Percent inhibition	Radial mycelial growth (cm)	Percent inhibition	Radial mycelial growth (cm)	Percent inhibition	Radial mycelial growth (cm)	Percent inhibition
1.	Lantana indica Roxb.	Leaves	4.5	Ø.Ø	4.Ø	11.11	3.3	26.66	1.9	57.77
2.	Launea asplenifolia Hook. f.	Leaves	4.5	Ø.Ø	4.5	Ø.Ø	4.5	Ø.Ø	3.8	15.55
3.	Adhatoda vasica Nees	Leaves	4.5	Ø.Ø	4.5	Ø.Ø	4.5	Ø.Ø	2.3	48.88
4.	Calotropis procera (Ait.) R.	Leaves	4.5	Ø.Ø	4.5	Ø.Ø	4.5	Ø.Ø	4.Ø	11.11
5.	Solanum xanthocarpum Schrad. & Wendl.	Leaves	4.5	Ø.Ø	4.5	Ø.Ø	4.5	Ø.Ø	3.8	15.55
6.	Jatropha gossipifolia Linn.	Leaves	4.5	Ø.Ø	4.5	Ø.Ø	4.5	Ø.Ø	3.6	2Ø.Ø
7.	Barleria prionitis Linn.	Leaves	4.5	Ø.Ø	4.5	Ø.Ø	4.5	Ø.Ø	4.Ø	11.11
8.	Parthenium hysterophorus Linn.	Leaves	4.5	Ø.Ø	4.5	Ø.Ø	4.Ø	11.11	3.1	31.11
9.	Azadirachta indica A. Juss.	Leaves	3.5	22.22	2.7	4Ø.Ø	2.2	51.11	1.6	64.44
1Ø.	Clerodendron phlolytis Linn.	Leaves	4.1	8.88	3.4	24.44	2.9	35.55	1.8	6Ø.Ø
11.	Catharanthus roseus G.Don.	Leaves	4.3	4.44	3.8	15.55	3.5	22.22	1.1	75.55
12.	Ocimum sanctum Linn.	Leaves	3.1	31.11	2.5	44.44	2.Ø	55.55	Ø.9	8Ø.Ø

Contd.

13.	Allium sativum Linn.	Leaves	4.Ø		11.11	4.Ø	11.11	3.7	17.77	Ø.2	95.55
14.	Allium cepa Linn.	Bulbs	4.5		Ø.Ø	4.5	Ø.Ø	4.5	Ø.Ø	3.2	28.88
15.	Allium sativum Linn.	Bulbs	Ø.Ø		100.Ø	Ø.Ø	100.Ø	Ø.Ø	100.Ø	Ø.Ø	100.Ø
16.	Zingiber officinalae Rosc.	Rhizomes	Ø.Ø		100.Ø	Ø.Ø	100.Ø	Ø.Ø	100.Ø	Ø.Ø	100.00
17.	Allium cepa Linn.	Leaves	4.5		Ø.Ø	4.5	Ø.Ø	4.5	Ø.Ø	4.5	Ø.Ø
18.	Control		4.5		-	4.5	-	4.5	-	4.5	-
	CD. at 5%		Ø.87		-	Ø.52	-	Ø.81	-	Ø.73	-
	CD. at 1%		Ø.41		-	2.96	-	1.14	-	1.Ø3	-

Each reading is an average of three replicates.
Incubation temperature 3Ø C, and 1ØØ% relative humidity.
Incubation period 72, hours.
Conc. - S1 = 25% ; S2 = 5Ø% ; S3 = 75% ; S4 = 1ØØ%

Fig. No. 6 (a) :- Effect of water soluble extracts of some plants on the radial mycelial growth of *Rhizopus stolonifer* (Ehrenb. ex. Fr.) Lind. (*In Vitro*).

A = *Lantana indica* Roxb.

B = *Launea asplenifolia* Hook. f.

C = *Adhatoda vasica* Nees.

D = *Calotropis procera* (Ait.) R.

E = *Solanum xanthocarpum* Schrad. & Wendl.

F = *Jatropha gossipifolia* Linn.

G = *Barleria prionitis* Linn.

H = *Parthenium hysterophorus* Linn.

Control (untreated).

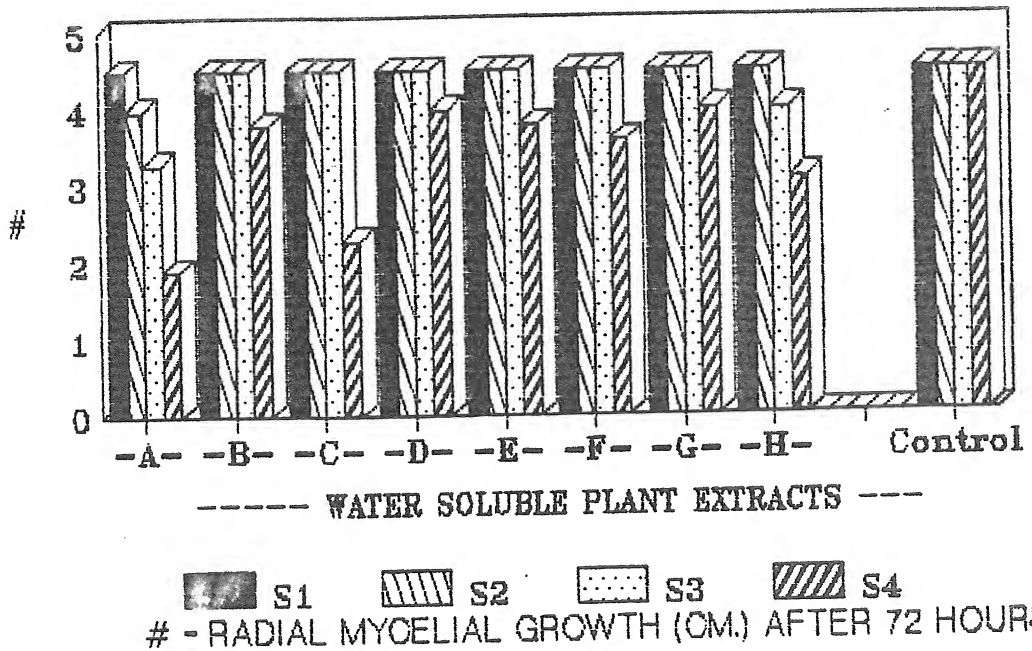


Fig. No. 6 (a) Conc. S1 - 25%; S2 - 50%; S3 - 75%; S4 - 100%

Fig. No. 6 (b) :- Effect of water soluble extracts of some plants on the radial mycelial growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind.

I = Azadirachta indica A. Juss.

J = Clerodendron phlolytis Linn.

K = Catharanthus roseus G. Don.

L = Ocimum sanctum Linn.

M = Allium sativum Linn. (leaves - part)

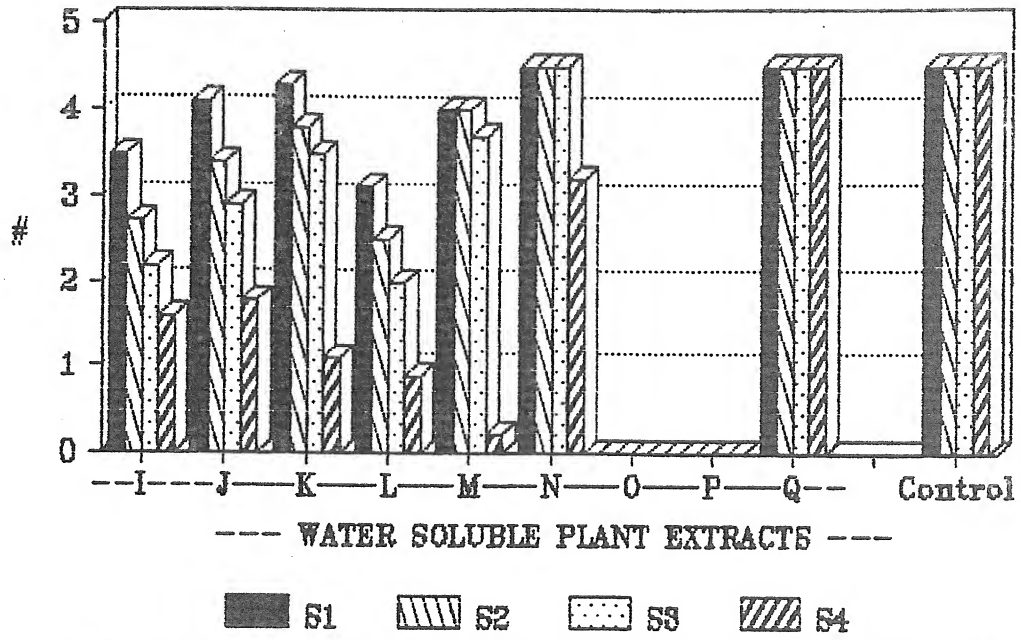
N = Allium cepa Linn. (bulbs - part)

O = Allium sativum Linn. (bulbs - part)

P = Zingiber officinale Rosc. (rhizome - part)

Q = Allium cepa Linn. (leaves - part)

Control (untreated).



- RADIAL MYCELIAL GROWTH (CM.) AFTER 72 HOURS

Fig. No. 6(b) Conc. S1 - 25%; S2 - 50%; S3 - 75%; S4 - 100%

Plate No. 14 (a) :- Effect of water soluble extracts of some plants on the radial mycelial growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. at different concentrations

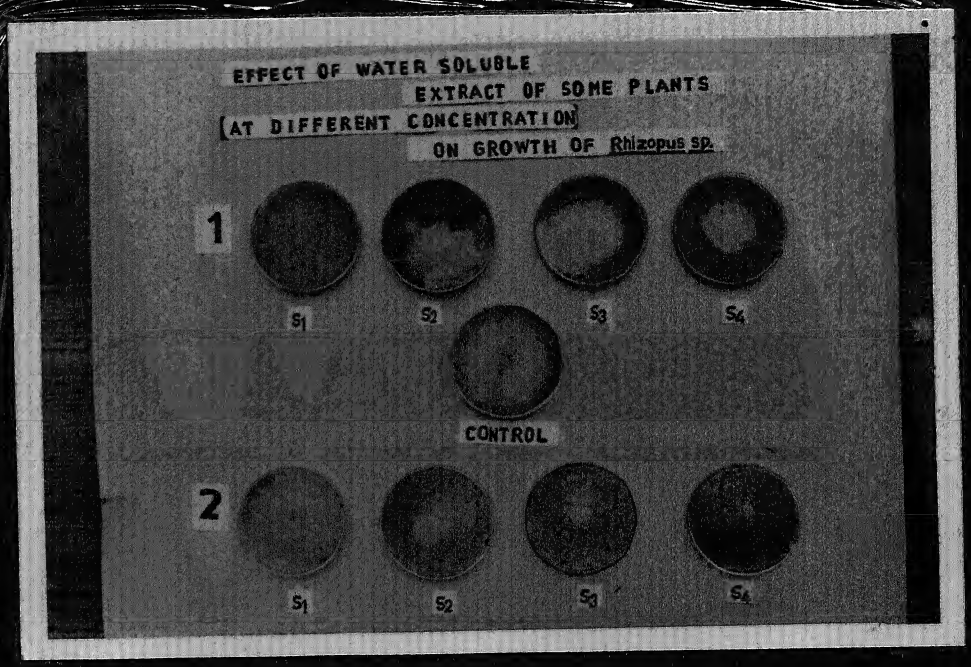
S1 = 25% Conc., S2 = 50% Conc., S3 = 75% Conc., S4 = 100% Conc.

1. Lantana indica Roxb.
2. Launea asplenifolia Hook. f.

Plate No. 14 (b) :- Effect of water soluble extracts of some plants on the radial mycelial growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. at different concentrations

S1 = 25% Conc., S2 = 50% Conc., S3 = 75% Conc., S4 = 100% Conc.

3. Adhatoda vasica Nees.
4. Calotropis procera (Ait.) R.


EFFECT OF WATER SOLUBLE
EXTRACT OF SOME PLANTS
(AT DIFFERENT CONCENTRATION
ON GROWTH OF Rhizopus sp.
1
S1
S2
S3
S4
CONTROL
2
S1
S2
S3
S4

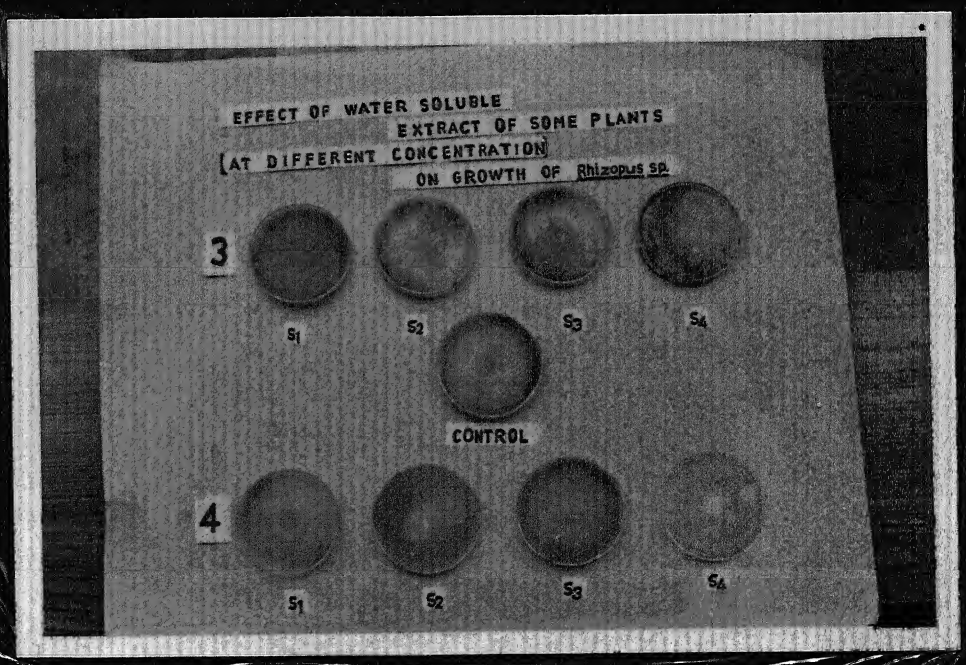

EFFECT OF WATER SOLUBLE
EXTRACT OF SOME PLANTS
(AT DIFFERENT CONCENTRATION
ON GROWTH OF Rhizopus sp.
3
S1
S2
S3
S4
CONTROL
4
S1
S2
S3
S4

Plate No. 14 (c) :- Effect of water soluble extracts of some plants on the radial mycelial growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. at different concentrations,

S1 = 25% Conc., S2 = 50% Conc., S3 = 75% Conc., S4 = 100% Conc.

5. Solanum xanthocarpum Schrad. & Wendl.

6. Jatropha gossipifolia Linn.

Plate No. 14 (d) :- Effect of water soluble extracts of some plants on the radial mycelial growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. at different concentrations,

S1 = 25% Conc., S2 = 50% Conc., S3 = 75% Conc., S4 = 100% Conc.

7. Barleria prionitis Linn.

8. Parthenium hysterophorus Linn.

Plate No. 14 (c) :- Effect of water soluble extracts of some plants on the radial mycelial growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. at different concentrations,

S1 = 25% Conc., S2 = 50% Conc., S3 = 75% Conc., S4 = 100% Conc.

5. Solanum xanthocarpum Schrad. & Wendl.

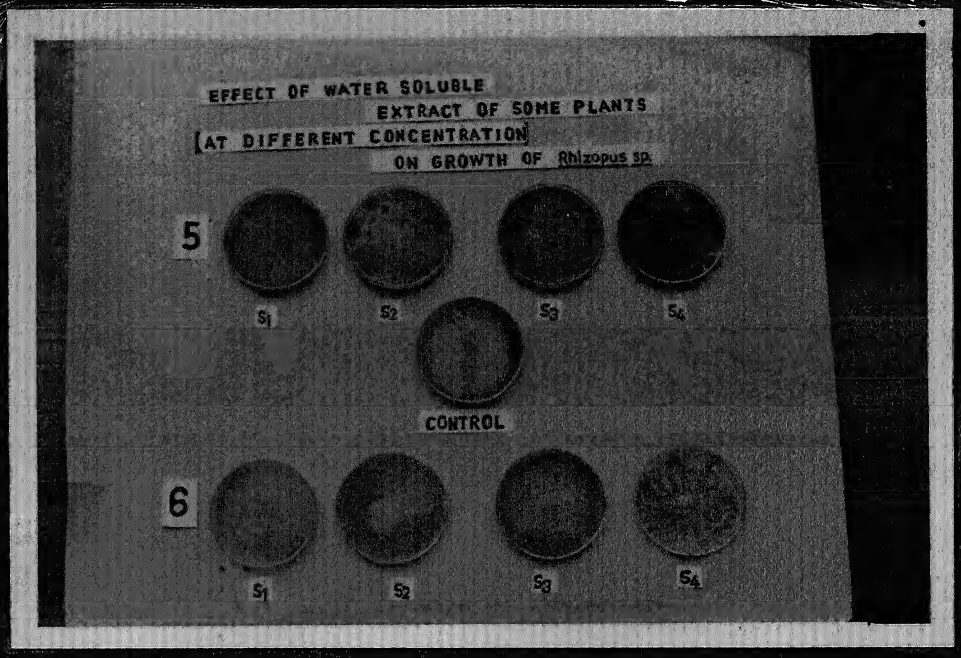
6. Jatropha gossipifolia Linn.

Plate No. 14 (d) :- Effect of water soluble extracts of some plants on the radial mycelial growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. at different concentrations,

S1 = 25% Conc., S2 = 50% Conc., S3 = 75% Conc., S4 = 100% Conc.

7. Barleria prionitis Linn.

8. Parthenium hysterophorus Linn.


EFFECT OF WATER SOLUBLE
EXTRACT OF SOME PLANTS
[AT DIFFERENT CONCENTRATION]
ON GROWTH OF Rhizopus sp.
5
S1
S2
S3
S4
CONTROL
6
S1
S2
S3
S4

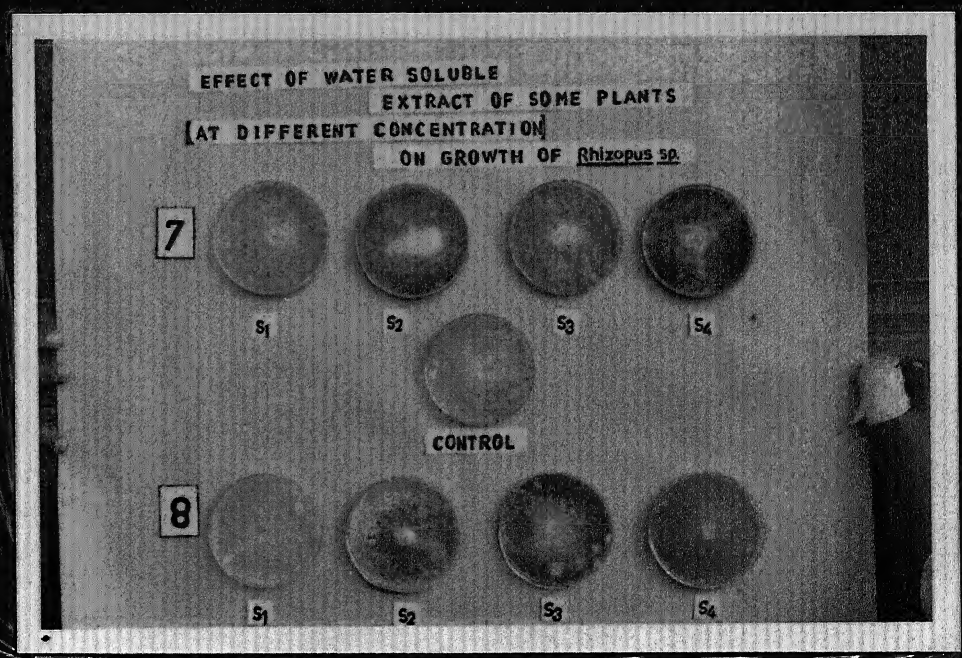

EFFECT OF WATER SOLUBLE
EXTRACT OF SOME PLANTS
[AT DIFFERENT CONCENTRATION]
ON GROWTH OF Rhizopus sp.
7
S1
S2
S3
S4
CONTROL
8
S1
S2
S3
S4

Plate No. 14 (e) :- Effect of water soluble extracts of some plants on the radial mycelial growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. at different concentrations,

S1 = 25% Conc., S2 = 50% Conc., S3 = 75% Conc., S4 = 100% Conc.

9. Azadirachta indica A. Juss.

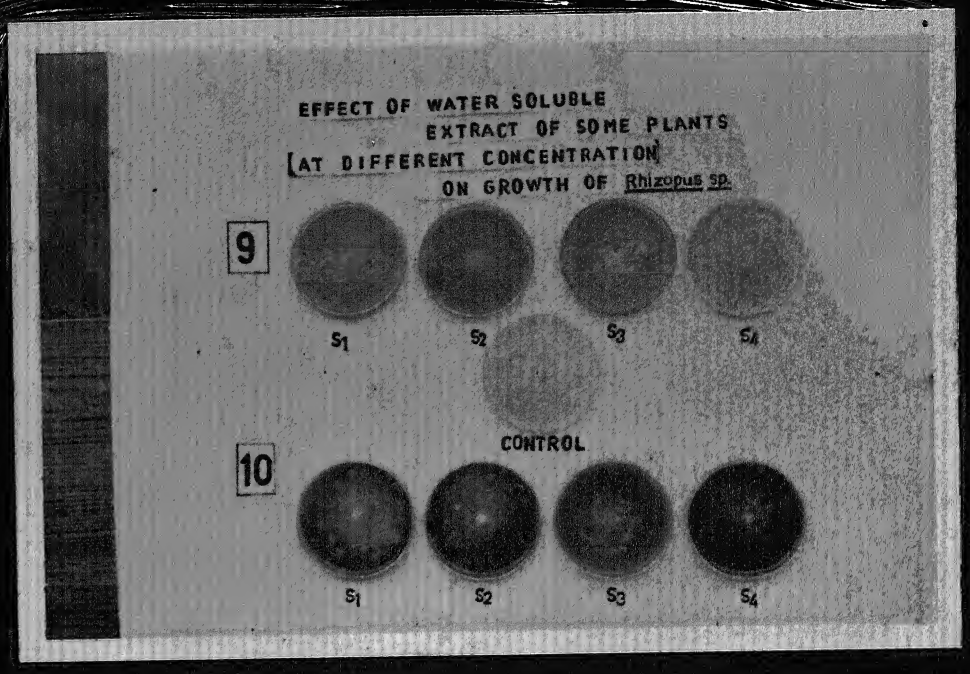
10. Clerodendron phlomis Linn.

Plate No. 14 (f) :- Effect of water soluble extracts of some plants on the radial mycelial growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. at different concentrations,

S1 = 25% Conc., S2 = 50% Conc., S3 = 75% Conc., S4 = 100% Conc.

11. Catharanthus roseus G. Don.

12. Ocimum sanctum Linn.


EFFECT OF WATER SOLUBLE
EXTRACT OF SOME PLANTS
AT DIFFERENT CONCENTRATION
ON GROWTH OF Rhizopus sp.
9
S1
S2
S3
S4
CONTROL
10
S1
S2
S3
S4

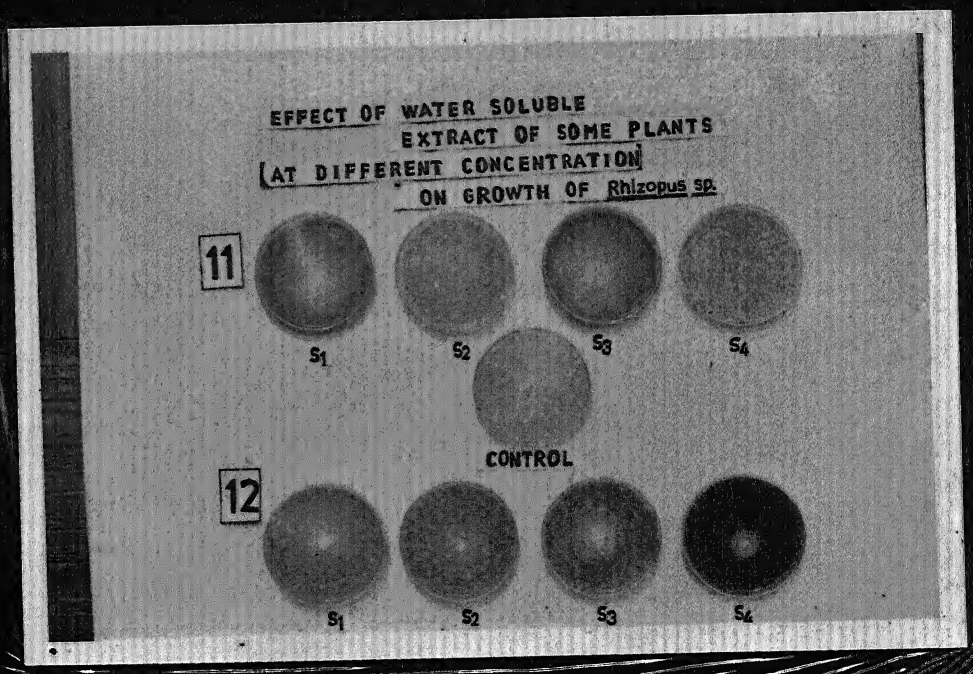

EFFECT OF WATER SOLUBLE
EXTRACT OF SOME PLANTS
AT DIFFERENT CONCENTRATION
ON GROWTH OF Rhizopus sp.
11
S1
S2
S3
S4
CONTROL
12
S1
S2
S3
S4

Plate No. 14 (g) :- Effect of water soluble extracts of some plants on the radial mycelial growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. at different concentration,

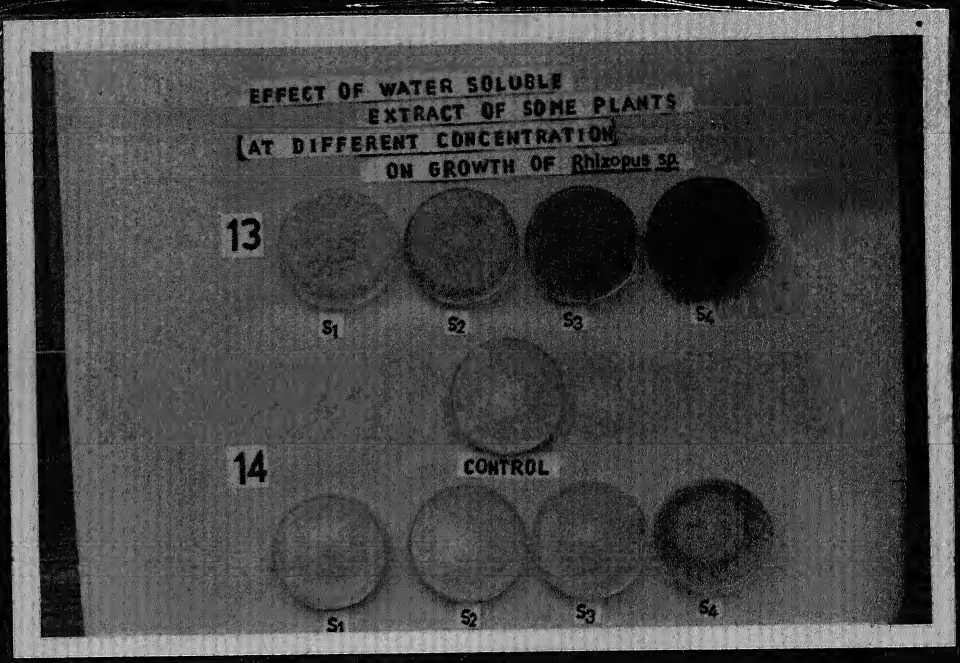
S1 = 25% Conc., S2 = 50% Conc., S3 = 75% Conc., S4 = 100% Conc.

13. Allium sativum Linn. (leaves - part)
14. Allium cepa Linn. (bulbs)

Plate No. 14 (h) :- Effect of water soluble extracts of some plants on the radial mycelial growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. at different concentration,

S1 = 25% Conc., S2 = 50% Conc., S3 = 75% Conc., S4 = 100% Conc.

15. Allium sativum Linn. (bulbs - part)
16. Zingiber officinale Rosc. (rhizome - part)


EFFECT OF WATER SOLUBLE
EXTRACT OF SOME PLANTS
(AT DIFFERENT CONCENTRATION)
ON GROWTH OF Rhizopus sp.
13
S1
S2
S3
S4
14
CONTROL
S1
S2
S3
S4

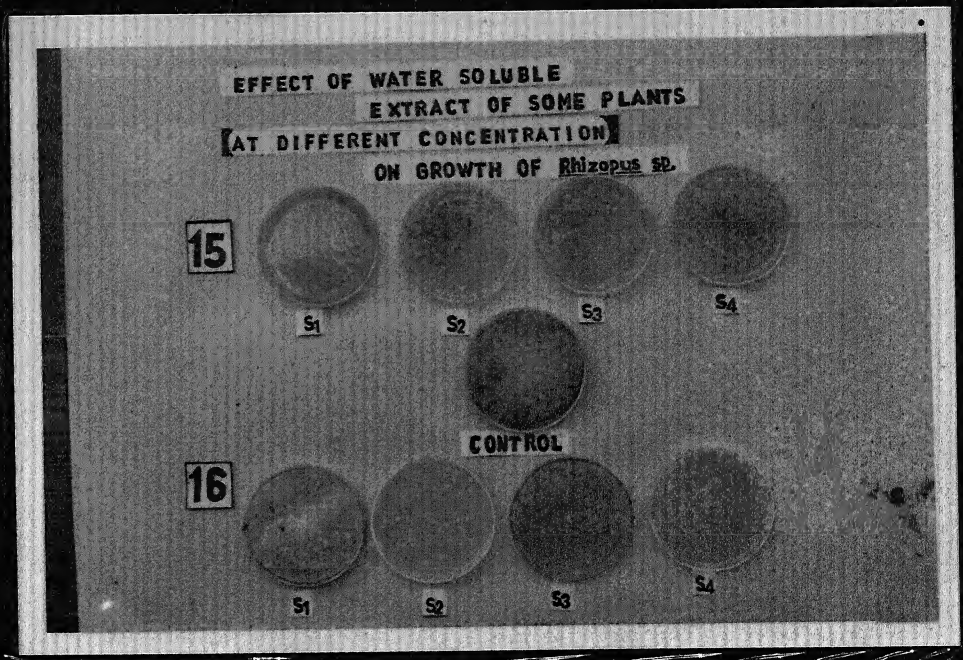

EFFECT OF WATER SOLUBLE
EXTRACT OF SOME PLANTS
(AT DIFFERENT CONCENTRATION)
ON GROWTH OF Rhizopus sp.
15
S1
S2
S3
S4
CONTROL
16
S1
S2
S3
S4

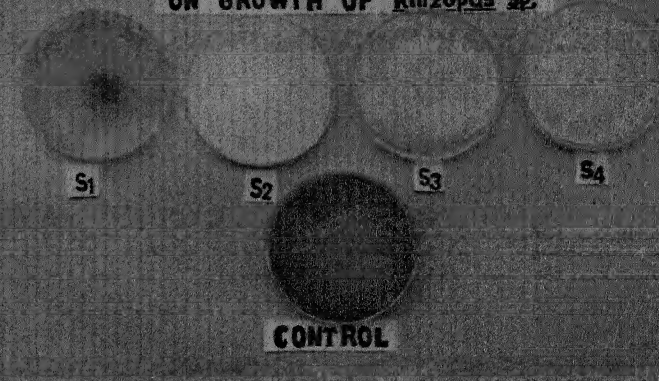
Plate No. 14 (i) :- Effect of water soluble extracts of some plants on the radial mycelial growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. at different concentration,

S1 = 25% Conc., S2 = 50% Conc., S3 = 75% Conc., S4 = 100% Conc.

17. Allium cepa Linn. (leaves - part)

EFFECT OF WATER SOLUBLE
EXTRACT OF SOME PLANTS
(AT DIFFERENT CONCENTRATION)
ON GROWTH OF *Rhizopus* sp.

17



period, respectively.

It is clear from the above that by increasing the concentration of the water soluble plant extracts a significant decrease in the radial mycelial growth was observed. Similarly increase in the percentage of inhibition was also observed in all the extracts tested except leaf extracts of Allium cepa.

7. EFFECT OF WATER-SOLUBLE FRACTIONS OF DIFFERENT OIL-CAKES ON THE GROWTH OF RHIZOPUS STOLONIFER (Ehrenb. ex. Fr.) Lind. (IN VITRO) :

The results presented in the Table No. (9); Plate No. (15a-15b); Fig. No.(7). to test the efficacy of water soluble fractions of four oil-cakes viz., Arachis hypogea Linn. (groundnut-cake), Ricinus communis Linn. (castor-cake), Madhuca indica J.F. Gemel. (mahua-cake) and Azadirachta indica A. Juss. (neem-cake) at three concentrations level i.e. 2.5% (S1), 5.Ø% (S2) and 1Ø.Ø% (S3) on the radial mycelial growth of R. stolonifer in in vitro revealed that the maximum percent inhibition (calculated as stated on page no.- 37) was recorded by the water soluble fractions of neem-cake followed by mahua-cake while minimum percent inhibition was recorded in castor-cake followed by groundnut-cake water soluble fractions obtained after 2, 6,

10 & 15 days of storage period. The minimum percent inhibition was observed in the above mentioned oil-cakes fractions obtained after two-days of storage and 24 hours of incubation period. The data showed that the percent inhibition was increased by increasing the concentration or the storage period of the water soluble fractions of oil-cakes.

The percent inhibition by the water soluble fractions obtained after two days of storage was 0.0%, 0.0%, 6.66% & 61.11% in S1 concentration; It was 0.0%, 0.0%, 28.88% & 64.0% in S2 concentration and it was 0.0%, 11.44%, 60.0% & 72.11% in S3 concentration after 24 hours of incubation period, respectively in all the water soluble fractions of four-oil-cakes tested. The percent inhibition in the extracts obtained after six days of storage was 0.0%, 0.0%, 13.33%, & 64.0% in S1 concentration; It was 0.0%, 6.66%, 33.33% & 69.77% in S2 concentration and it was 2.22%, 6.66%, 66.66% & 74.66% in S3 concentraion after 24 hours of incubation periods, respectively in all the water soluble fractions of four oil-cakes tested. The percent inhibition in the water soluble fractions obtained after ten days of storage period was 0.0%, 0.0%, 69.55%, & 68.66% in S1 concentration; It was 2.22%, 6.66%, 77.77%, & 84.22% in S2 concentration and it was 6.66%, 11.11%, 80.0% & 78.66% in S3 concentration

TABLE NO. 9 : EFFECT OF WATER-SOLUBLE FRACTIONS OF OIL-CAKES ON THE RADIAL MYCELIAL GROWTH OF RHIZOPUS STOLONIFER (IN VITRO) :

S. No.	Oil-Cakes Used	Concentration (%)	Storage periods of water soluble fractions of oil-cakes (Days)							
			2		6		10		15	
			Radial mycelial growth (cm.)	Percent inhibition	Radial mycelial growth (cm.)	Percent inhibition	Radial mycelial growth (cm.)	Percent inhibition	Radial mycelial growth (cm.)	Percent inhibition
1.	Arachis hypogea Linn. (groundnut-cake)	S1	4.5	Ø.Ø	4.5	Ø.Ø	4.5	Ø.Ø	4.4	2.22
		S2	4.5	Ø.Ø	4.5	Ø.Ø	4.4	2.22	4.2	6.66
		S3	4.5	Ø.Ø	4.4	2.22	4.2	6.66	4.Ø	11.11
2.	Ricinum communis Linn. (castor-cake)	S1	4.5	Ø.Ø	4.5	Ø.Ø	4.5	Ø.Ø	4.4	2.22
		S2	4.5	Ø.Ø	4.2	6.66	4.2	6.66	4.Ø	11.11
		S3	4.3	11.44	4.2	6.66	4.Ø	11.11	3.8	15.55
3.	Madhuca indica J.F. Gmel. (mahua-cake)	S1	4.2	6.66	3.9	13.33	1.37	69.55	1.15	74.44
		S2	3.2	28.88	3.Ø	33.33	1.Ø	77.77	1.Ø	77.77
		S3	1.8	6Ø.Ø	1.5	66.66	Ø.9Ø	8Ø.Ø	Ø.8Ø	82.22

Contd.

4.	Azadirachta indica A.Juss. (neem-cake)	S1	1.75	61.11	1.62	64.Ø	1.50	66.66	1.28	71.55
		S2	1.62	64.ØØ	1.36	69.77	Ø.71	84.22	Ø.4Ø	91.11
		S3	1.25	72.22	1.14	74.66	1.Ø5	76.66	Ø.ØØ	1ØØ.Ø
5.	Control	-	4.5	-	4.5	-	4.5	-	4.5	-
	CD. at 5%	-	Ø.7Ø	-	1.Ø9	-	Ø.84	-	Ø.Ø9	-
	CD. at 1%	-	Ø.99	-	1.53	-	1.18	-	Ø.13	-

Each reading is an average of three replicates.
Inoculated plates were incubated at 3Ø C temperature and 100% relative humidity.
Incubation period 24 hours
Conc. - S1 = 2.5% ; S2 = 5.Ø% ; S3 = 1Ø.Ø%

Fig. No. 7 :- Effect of water soluble fractions of oil-cakes on the radial mycelial growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. (In Vitro).

A = Arachis hypogea Linn. (groundnut-cake)

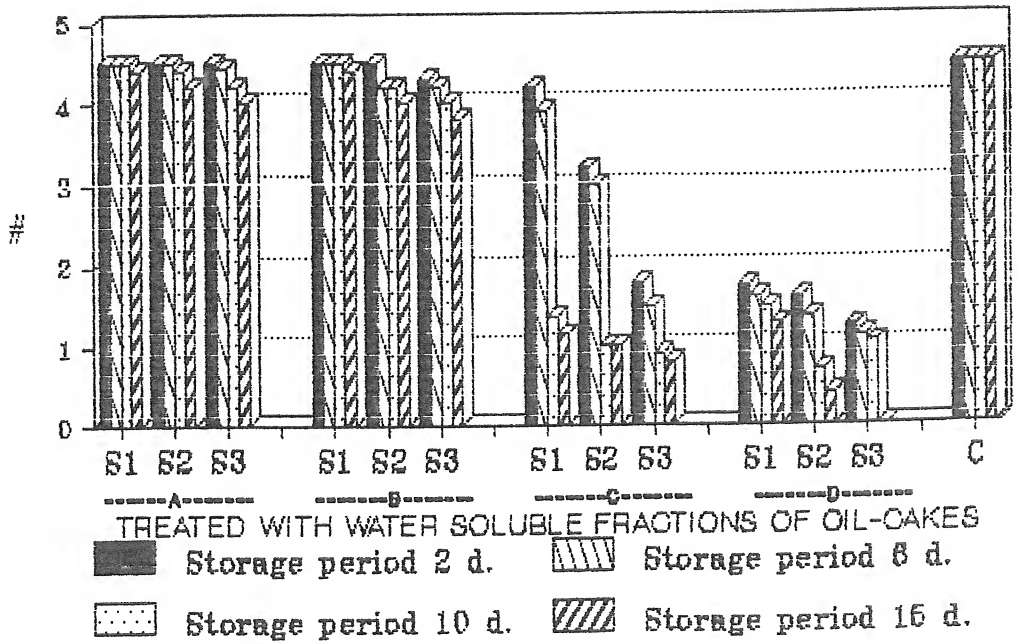
B = Ricinus communis Linn. (castor-cake)

C = Madhuca indica J. F. Gmel. (mahua-cake)

D = Azadirachta indica A. Juss. (neem-cake)

S1 = 2.5% Conc., S2 = 5.0% Conc., S3 = 10.0% Conc.

C = Control (untreated), d = Days.



- RADIAL MYCELIAL GROWTH (cm.)

Fig. No. 7 Conc. :- S1 - 2.5%; S2 - 5.0%; S3 - 10.0%

Plate No. 15 (a) :- Effect of water soluble fractions of oil-cakes obtained after six days storage period, on the radial mycelial growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind.

S1 = 2.5% Conc., S2 = 5.Ø% Conc., S3 = 1Ø.Ø% Conc.

1. Arachis hypogea Linn. (groundnut-cake)
2. Ricinus communis Linn. (castor-cake)
3. Madhuca indica J. F. Gmel (mahua-cake)
4. Azadirachta indica A. Juss.(neem-cake)

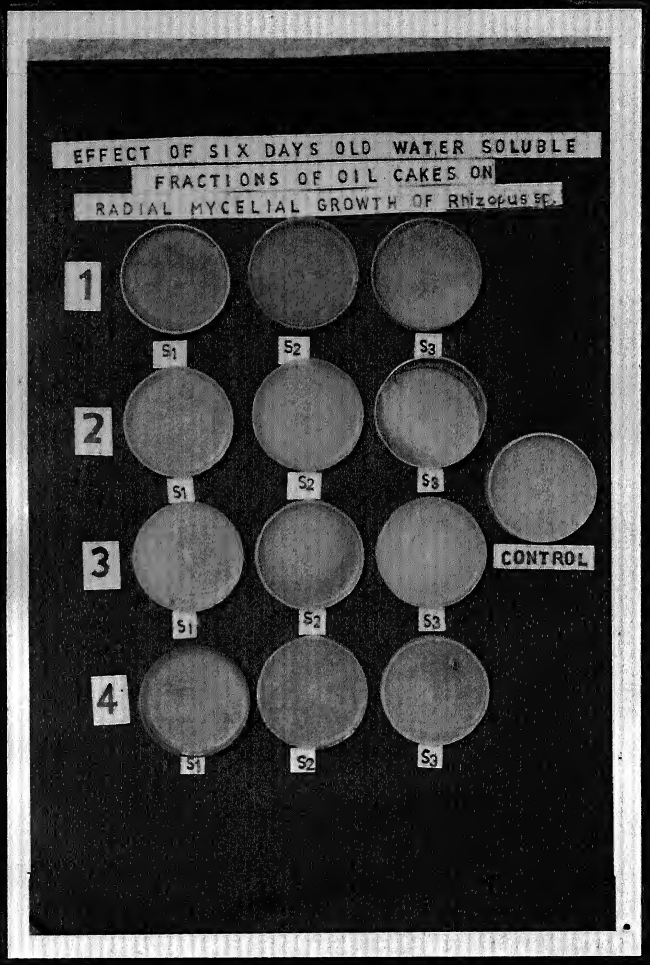
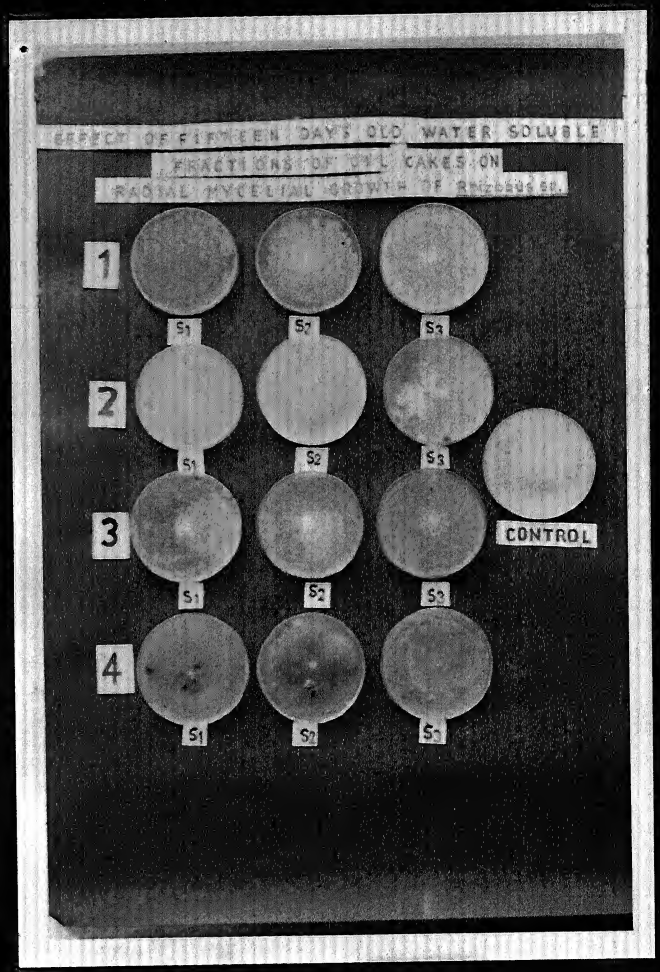

EFFECT OF SIX DAYS OLD WATER SOLUBLE
FRACTIONS OF OIL CAKES ON
RADIAL MYCELIAL GROWTH OF Rhizopus sp.
1
2
3
4
S1
S2
S3
CONTROL

Plate No. 15 (b) :- Effect of water soluble fractions of oil-cakes obtained after fifteen days of storage period, on the radial mycelial growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind.

S1 = 2.5% Conc., S2 = 5.0% Conc., S3 = 10.0% Conc.

1. Arachis hypogea Linn. (groundnut-cake)
2. Ricinus communis Linn. (castor-cake)
3. Madhuca indica J. F. Gmel. (mahua-cake)
4. Azadirachta indica A. Juss. (neem-cake)


EFFECT OF FIFTEEN DAYS OLD WATER SOLUBLE
FRACTIONS OF OIL CAKES ON
RADIAL MYCELIAL GROWTH OF RHIZOBIUM SP.
1
2
3
4
S1
S2
S3
CONTROL

after 24 hours of incubation periods, respectively in all the water soluble fractions of four oil-cakes tested after 24 hours of incubation period. The percent inhibition in the water soluble fractions obtained after fifteen days of storage period was 2.22%, 2.22%, 74.44% & 71.55% in S1 concentration; It was 6.66%, 11.11%, 77.77% & 91.11% in S2 concentration and it was 11.11% 15.55%, 82.22% & 100.0% in S3 concentration after 24 hours of incubation period, respectively in all the water soluble fractions of four oil-cakes tested.

8. EFFECT OF WATER-SOLUBLE EXTRACTS OF SOIL-AMENDED WITH DIFFERENT OIL-CAKES ON THE GROWTH OF THE RHIZOPUS STOLONIFER (Ehrenb. ex. Fr.) Lind. (IN VITRO) :

The results presented in the Table No.(10); Plate No. (16a-16b); Fig. No.(8), to test the efficacy of water soluble extracts of soil-amended with four oil-cakes viz., Arachis hypogea Linn. (groundnut-cake), Ricinus communis Linn. (castor-cake), Madhuca indica J.F. Gmel. (mahua-cake) and Azadirachta indica A. Juss. (neem-cake) at three concentration level i.e. 2.5% (S1), 5.0% (S2), 10.0% (S3) on the radial mycelial growth of R. stolonifer in in vitro revealed that the maximum percent inhibition (calculated as stated on page no. 37) was recorded in the water soluble extracts of soil-amended with neem-cake

followed by mahua-cake while minimum inhibition was recorded in the water soluble extracts of soil-amended with castor and groundnut-cake obtained after 2, 6, 1Ø & 15 days of storage period. The less percent inhibition was recorded in all the four soil-amended oil-cakes extracts obtained after two days of storage period. The percent inhibition showed increasing trend by increasing the concentration and storage period of water soluble extracts of soil-amended with oil-cakes.

The percent inhibition by the extracts obtained after two days of storage was Ø.Ø%, Ø.Ø%, 41.77% & 22.22% in S1 concentration; It was Ø.Ø%, 6.66%, 44.44% & 44.44% in S2 concentration; It was 4.44%, 28.88%, 66.66% & 61.11% in S3 concentration after 24 hours of incubation period, respectively in all the four water soluble extracts of soil-amended with oil-cakes tested. The percent inhibition in the water soluble extracts of soil-amended with oil-cakes obtained after six days of storage period was Ø.Ø%, 4.Ø% 44.44% & 38.88% in S1 concentration; It was 4.44%, 11.11%, 61.11% & 55.55% in S2 concentration; It was 6.66%, 33.33%, 72.22% & 66.66% in S3 concentration after 24 hours of incubation period, respectively in all the four soil-amended

TABLE NO. 10 : EFFECT OF WATER SOLUBLE EXTRACTS OF SOIL-AMENDED WITH OIL-CAKES ON THE RADIAL MYCELIAL GROWTH OF RHIZOPUS STOLONIFER (IN VITRO) :

S. No.	Oil-Cakes Used	Concentration (%)	Storage periods of water soluble extracts of soil-amended with oil-cakes. (Days)							
			2		6		10		15	
			Radial mycelial growth (cm)	Percent inhibition	Radial mycelial growth (cm)	Percent inhibition	Radial mycelial growth	Percent inhibition	Radial mycelial growth (cm)	Percent inhibition
1.	Arachis hypogea Linn. (groundnut-cake)	S1	4.5	0.0	4.5	0.0	4.4	2.22	2.5	44.44
		S2	4.5	0.0	4.3	4.44	4.0	11.11	4.0	11.11
		S3	4.3	4.44	4.2	6.66	4.0	11.11	4.0	11.11
2.	Ricinus communis Linn. (castor-cake)	S1	4.5	0.0	4.32	4.0	4.2	6.66	4.0	11.11
		S2	4.2	6.66	4.0	11.11	3.33	26.0	3.0	33.33
		S3	3.2	28.88	3.0	33.33	2.82	37.33	2.5	44.44
3.	Madhuca indica J.F. Gmel. (mahua-cake)	S1	2.62	41.77	2.5	44.44	2.25	50.0	2.0	55.55
		S2	2.5	44.44	1.75	61.11	1.70	62.22	1.0	77.77
		S3	1.5	66.66	1.25	72.22	1.0	77.77	0.8	82.22

Contd.

4.	Azadirachta indica A.Juss. (neem-cake)	S1	3.5	22.22	2.75	38.88	2.5	44.44	1.87	58.44
		S2	2.5	44.44	2.0	55.55	1.5	66.66	Ø.8Ø	82.22
		S3	1.7	61.11	1.5	66.6	Ø.6	66.66	Ø.ØØ	1ØØ.Ø
5.	Control	-	4.5	-	4.5	-	4.5	-	4.5	-
	CD. at 5%		Ø.85	-	Ø.96	-	Ø.87	-	Ø.71	-
	CD. at 1%		1.19	-	1.35	-	1.23	-	1.ØØ	-

Each reading is an average of three replicates.
Inoculated plates were incubated at 3Ø C temperature and 1ØØ% relative humidity.
Incubation period 24 hours.
Conc. - S1 = 2.5% ; S2 = 5.Ø% ; S3 = 1Ø.Ø%

Fig. No. 8 :- Effect of water soluble extracts of soil-amemded with oil-cakes on the radial mycelial growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. (In Vitro).

A = Soil ± Groundnut-cake

B = Soil ± Castor-cake

C = Soil ± Mahua-cake

D = Soil ± Neem-cake

S1 = 2.5% Conc., S2 = 5.0% Conc., S3 = 10.0% Conc.

C = Control (untreated), d = Days.

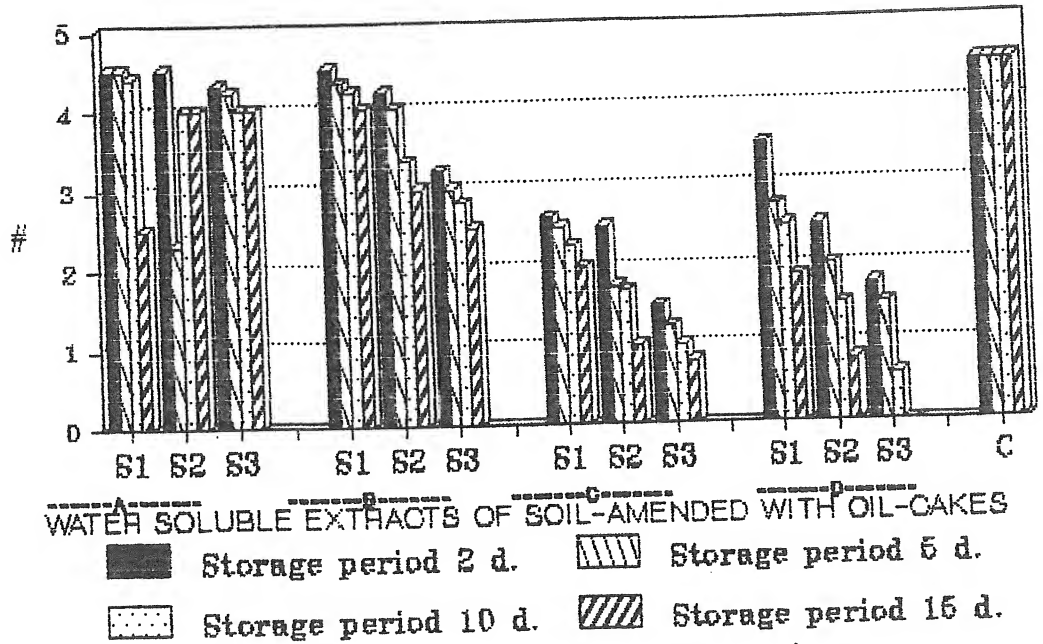

5
4
3
2
1
0
#
S1 S2 S3
S1 S2 S3
S1 S2 S3
S1 S2 S3
C
A
B
C
D
WATER SOLUBLE EXTRACTS OF SOIL-AMENDED WITH OIL-CAKES
Storage period 2 d.
Storage period 5 d.
Storage period 10 d.
Storage period 15 d.
- RADIAL MYCELIAL GROWTH (cm.)
Conc. :- S1 - 2.5%; S2 - 5.0%; S3-10.0%

Fig. No. 6

Plate No.16 (a) :- Effect of water soluble extracts of soil-amended with oil-cakes obtained after six days of storage period, on the radial mycelial growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind.

S1 = 2.5% Conc., S2 = 5.Ø% Conc., S3 = 1Ø.Ø% Conc.

1. Soil ± Groundnut-cake
2. Soil ± Castor-cake
3. Soil ± Mahua-cake
4. Soil ± Neem-cake

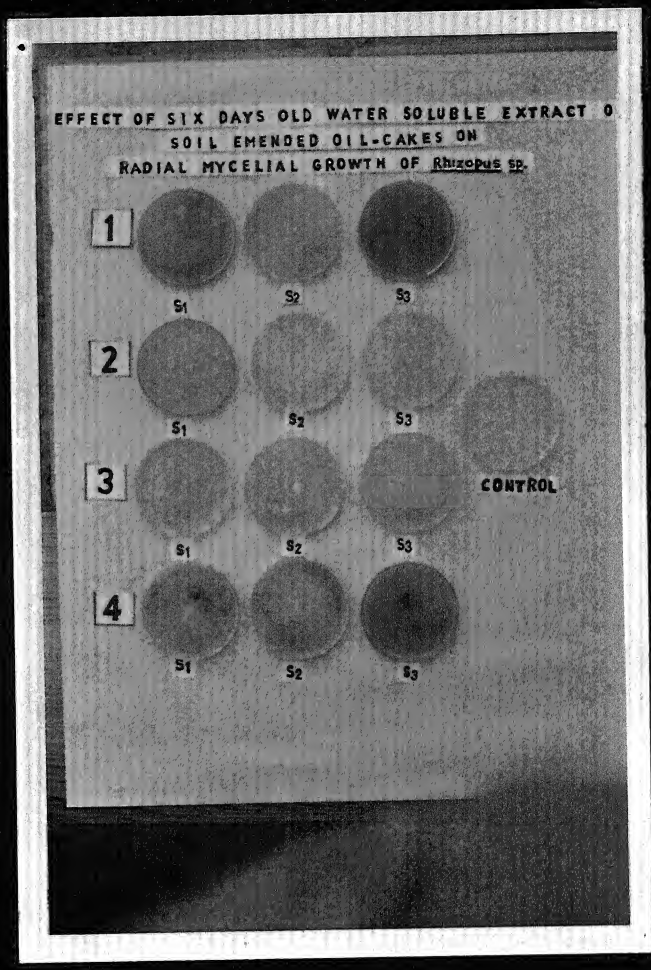

EFFECT OF SIX DAYS OLD WATER SOLUBLE EXTRACT O
SOIL EMENDED OIL-CAKES ON
RADIAL MYCELIAL GROWTH OF Rhizopus sp.
1
S1
S2
S3
2
S1
S2
S3
3
CONTROL
S1
S2
S3
4
S1
S2
S3

Plate No. 16 (b) :- Effect of water soluble extracts of soil-amended with oil-cakes obtained after fifteen days of storage period, on the radial mycelial growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind.

S1 = 2.5% Conc., S2 = 5.Ø% Conc., S3 = 1Ø.Ø% Conc.

1. Soil + Groundnut-cake
2. Soil + Castor-cake
3. Soil + Mahua-cake
4. Soil + Neem-cake

S1 = 2.5% , S2 = 5.Ø% , S3 = 1Ø.Ø%

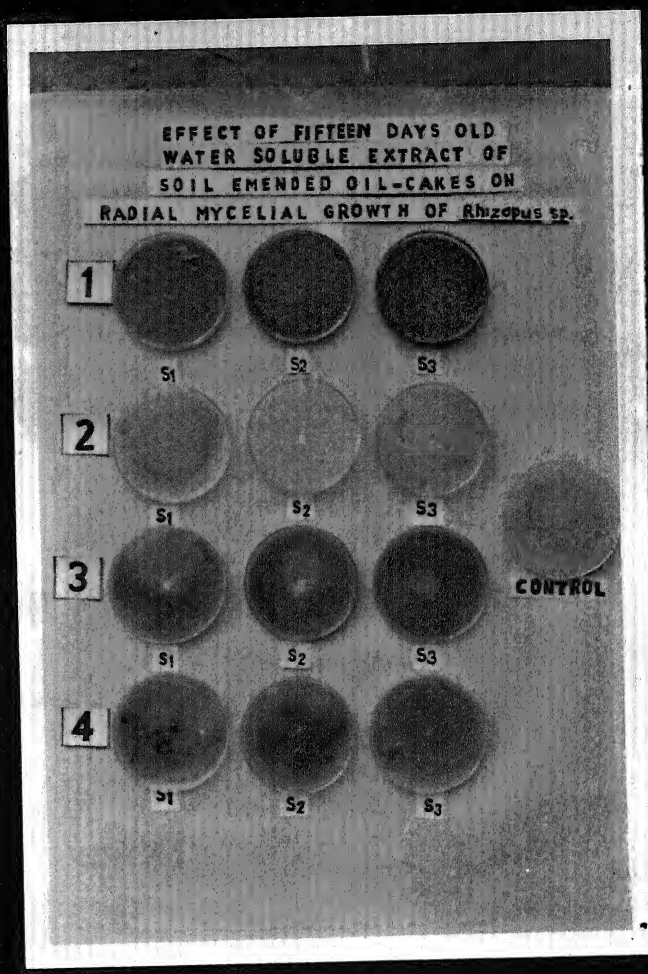

EFFECT OF FIFTEEN DAYS OLD
WATER SOLUBLE EXTRACT OF
SOIL EMENDED OIL-CAKES ON
RADIAL MYCELIAL GROWTH OF Rhizopus sp.
1
S1
S2
S3
2
S1
S2
S3
3
S1
S2
S3
CONTROL
4
S1
S2
S3

TABLE NO.11 : EFFECT OF WATER SOLUBLE EXTRACTS OF SOIL AMENDED WITH AMINO-ACIDS ON THE RADIAL MYCELIAL GROWTH OF RHIZOPUS STOLONIFER (IN VITRO) :

S. No.	Amino-acid Used	Storage periods of extracts of soil-amended with Amino acids (Days)							
		2		6		10		15	
		Radial mycelial growth (cm)	Percent inhibition	Radial mycelial growth (cm)	Percent inhibition	Radial mycelial growth (cm)	Percent inhibition	Radial mycelial growth (cm)	Percent inhibition
1.	Glutamic acid	4.5	Ø.ØØ	4.5	Ø.Ø	4.5	11.11	3.53	21.53
2.	Proline	4.5	Ø.ØØ	4.5	Ø.Ø	3.5	22.22	3.Ø	33.33
3.	Arginine	2.91*	35.33	2.91*	35.33	1.38*	69.33	Ø.96*	78.66
4.	Methionine	4.Ø	11.11	3.59	2Ø.22	3.Ø	33.33	1.7*	62.22
5.	Threonine	3.53*	22.22	3.Ø	33.33	2.85*	36.66	1.43*	68.22
6.	Leucine	4.Ø	11.11	3.35	25.55	2.85*	36.66	1.2*	73.33
7.	Tyrosine	2.5*	44.44	2.46*	45.33	2.36*	47.55	2.Ø6*	54.22
8.	Control	4.5Ø	-	4.5Ø	-	4.5Ø	-	4.5Ø	-
	CD. at 5%	Ø.48	-	Ø.49	-	Ø.92	-	Ø.56	-
	CD. at 1%	Ø.67	-	Ø.69	-	1.3Ø	-	Ø.79	-

Each reading is an average of three replicates.
Incubation period, 24 hours.
Incubation temperature 3Ø C and 1ØØ% relative humidity
PF = plated filled.
* = Significant at 1% level against untreated (control)

Fig. No. 9 :- Effect of water soluble extracts of soil-amended with amino-acids on the radial mycelial growth of *Rhizopus stolonifer* (Ehrenb. ex. Fr.) Lind. (*In Vitro*).

A = *Glutamic acid*

B = *Proline*

C = *Arginine*

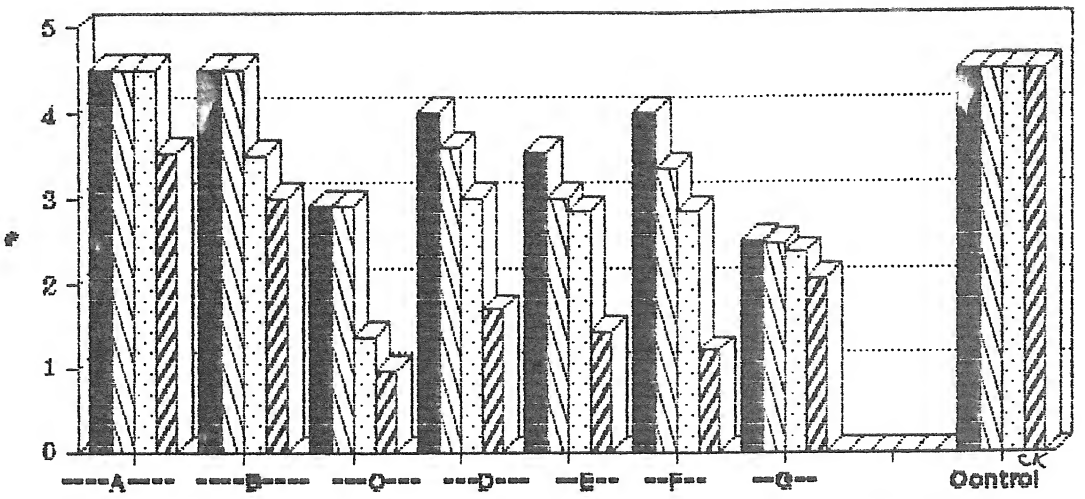
D = *Methionine*

E = *Threonine*

F = *Leucine*

G = *Tyrosine*

Ck = Control (untreated), d = Days



Extracts of soil amended with amino-acid

Storage period 2 d.
Storage period 5 d.
Storage period 10 d.
Storage period 15 d.

*=Radial mycelial growth (c.m.)

Fig. No. 9

Incubation period 24 hrs. & temp. 30 C

Plate No. 17 (a) :-

Effect of water soluble extracts of soil-amended with amino-acids obtained after six days of storage period, on the radial mycelial growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind.

1. Glutamic acid 2. Proline 3. Arginine
4. Methionine 5. Threonine 6. Leucine
7. Tyrosine

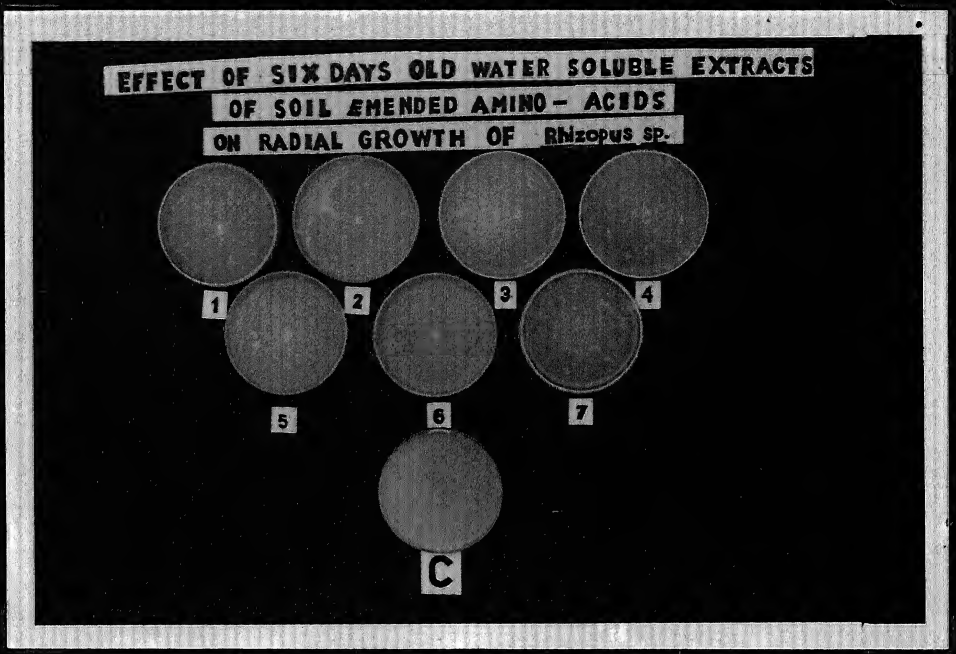
C = Control (untreated).

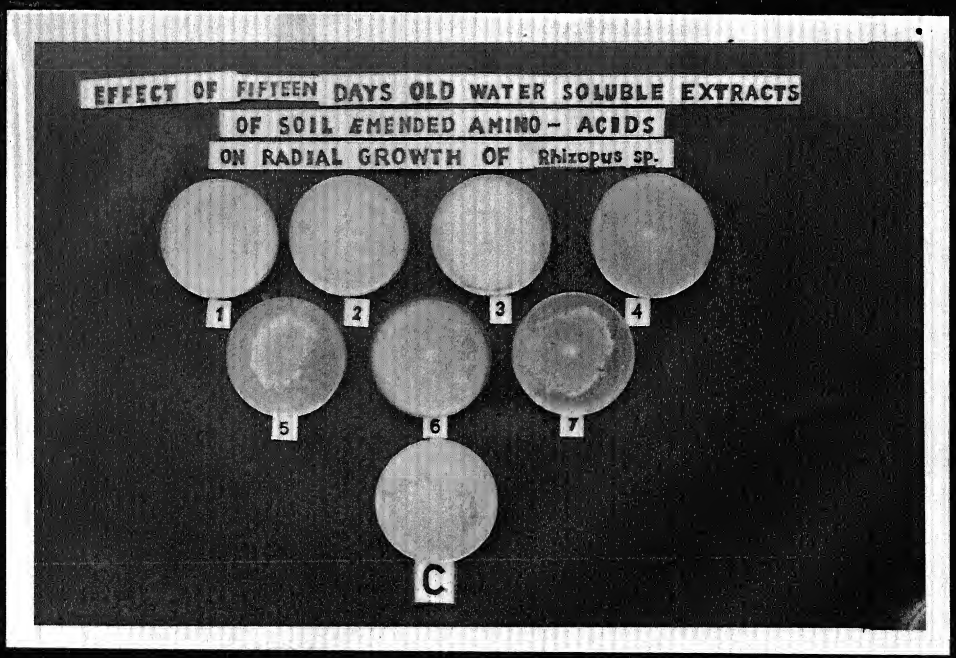
Plate No. 17 (b) :-

Effect of water soluble extracts of soil-amended with amino-acids obtained after fifteen days of storage period, on the radial mycelial growth of Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind.

1. Glutamic acid 2. Proline 3. Arginine
4. Methionine 5. Threonine 6. Leucine
7. Tyrosine

C = Control (untreated).


EFFECT OF SIX DAYS OLD WATER SOLUBLE EXTRACTS
OF SOIL AMENDED AMINO - ACIDS
ON RADIAL GROWTH OF Rhizopus sp.
1
2
3
4
5
6
7
C


EFFECT OF FIFTEEN DAYS OLD WATER SOLUBLE EXTRACTS
OF SOIL AMENDED AMINO - ACIDS
ON RADIAL GROWTH OF Rhizopus sp.
1
2
3
4
5
6
7
C

mycelial growth of the test pathogen revealed that the maximum percentage inhibition was observed in **Arginine, Leucine** and **Threonine** and the least percentage inhibition was observed in **Glutamic acid** and **Proline** extracts obtained after 2, 6, 1Ø and 15 days of storage period. Similarly methionine and threonine also showed significant inhibitory effect on radial mycelial growth of R. stolonifer.

The data presented in the table showed that percent inhibition was Ø.Ø%, Ø.Ø%, Ø.Ø%, Ø.Ø% & 21.55% in the extracts of soil amended with Glutamic acid; It was Ø.Ø%, Ø.Ø%, 22.22% & 33.33% in the extract of soil amended with proline amino-acid; 35.33%, 35.33%, 69.33% & 78.66% by the extracts of soil amended with Arginine amino acids; 11.11%, 2Ø.22%, 33.33%, & 62.22% in the extract of soil-amended with methionine, 22.22%, 33.33%, 36.66%, & 68.22% by the extract of soil amended with threonine; 11.11%, 25.55%, 36.66%, & 73.33 in the extracts of soil-amended with leucine and 44.44%, 45.33%, 47.55%, & 54.22% in the extracts of soil-amended with tyrosine extracts obtained after 2, 6, 1Ø & 15 days of storage period after 24 hours of incubation period, respectively.

1Ø (A). **EFFICACY OF PRE AND POST-DIP TREATMENTS OF SOME FUNGICIDES ON THE DEVELOPMENT OF SOFT-ROT IN PREMATURE JACK-FRUITS (IN VIVO) :**

The data presented in the Table No. (12a-12b); Fig. No. (1Øa-1Øb); Plate No. (18a-18c) and (19a-19b) to test the efficacy of five fungicides viz., **Bavistin [2-(Methoxy carbamolyl-benzalmidazole)], Dithane $M-_{45}$ [Zinc ions & Manganous ethylene bis (dithiocarbamate)], Benlate [Methyl - 1(buta carbomyl) -2 benzomidazole], Thiram [Tetramethyl thiaram disulphide]** and **Captan [N-Trichloromethyl thio -4-Cyclohexene 1,2 - dithiocarboximide]** at Ø.2% (S1) Ø.3% (S2) and Ø.5% (S3) percent concentration on premature falling in jack-fruits due to soft-rot caused by Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind., revealed that all fungicides tested were found effective against disease development in both pre and post-dip treatments after 72 hours of incubation period. It is clear from the data that pre-dip treatment was found to be most effective followed by post-dip treatment. The maximum percent inhibition of soft-rot development over control (calculated as stated on page no. 43) was recorded by Bavistin, Benlate followed Dithane M-45 in both pre & post-dip treatments. Minimum efficacy over control was recorded by Thiram while least inhibition over control was recorded by Captan in both pre and post-dip treatments after 72 hours of incubation period, respectively. The experimental data showed increasing trend in percent inhibition by increasing the concentration of fungicides.

TABLE 12 (A) : EFFECT OF PRE-DIP TREATMENTS OF FUNGICIDES ON THE DEVELOPMENT OF SOFT ROT- IN PREMATURE JACK-FRUITS (IN VIVO).

S.No.	FUNGICIDES (Active ingredients)	Concentration (%)	Percent soft-rot (Hours) 24	48	72	Percent inhibition over control
1.	Bavistin 2-(Methoxy carbamolyl-benzalmidazole)	S1	Ø.Ø	Ø.Ø	1.Ø	98.37
		S2	Ø.Ø	Ø.Ø	Ø.Ø	1ØØ.Ø
		S3	Ø.Ø	Ø.Ø	Ø.Ø	1ØØ.Ø
2.	Dithame M-45 (Zinc ions & manganous ethylene bis (dithio-carbamate)	S1	1.Ø	3.Ø6	6.38	89.66
		S2	Ø.Ø	Ø.Ø	Ø.Ø	1ØØ.Ø
		S3	Ø.Ø	Ø.Ø	Ø.Ø	1ØØ.Ø
3.	Thiram (Tetramethyl thiuram disulphide)	S1	Ø.Ø	1.5Ø	3.Ø3	95.Ø9
		S2	Ø.Ø	Ø.82	1.55	97.48
		S3	Ø.Ø	Ø.Ø	Ø.Ø	1ØØ.Ø
4.	Captan N-Trichloromethyl thio-4-cyclohexene-1,2-dithiocarboximide	S1	13.69	22.2	31.Ø	49.77
		S2	3.1Ø	9.96	23.6Ø	61.76
		S3	2.Ø9	8.92	19.Ø9	69.Ø6

Contd.

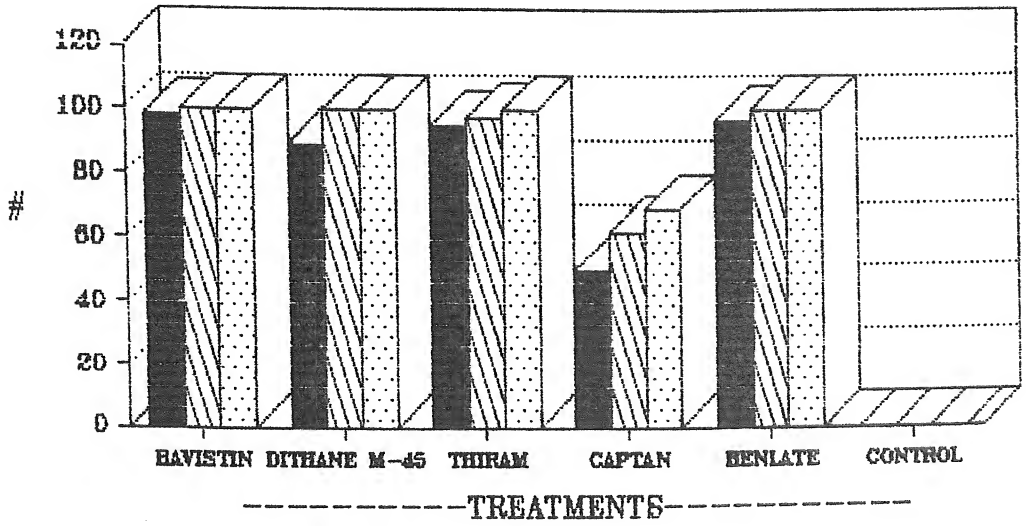
5.	Benlate Methyl-1(buta carbo-moyl)-2 benzamidazole	S1	Ø.Ø	1.12	2.Ø	96.75
		S2	Ø.Ø	Ø.Ø	Ø.Ø	1ØØ.Ø
		S3	Ø.Ø	Ø.Ø	Ø.Ø	1ØØ.Ø
6.	Control	-	13.7Ø	24.11	CFR	-
	CD. at 5%		2.19	7.2Ø	6.6Ø	-
	CD. at 1%		3.Ø7	1Ø.11	9.27	-

Note :- Each reading is an average of three replicates
inoculated fruits were incubated at 3Ø C temperature and 1ØØ% R.H.
Percent rot was calculated as described by Gaur and Chenulu (1982).
Conc. - S1=Ø.Ø2% ; S2=Ø.3% ; S3 = Ø.5%
CFR = Complete Fruit Rotten.

Fig. No. 1Ø (a) :- Effect of pre-dip treatments of fungicides on the development of soft-rot in premature Jack-fruits (Artocarpus heterophyllus Lamk.) inoculated with Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. (In Vivo)

S1 = Ø.2% Conc., S2 = Ø.3% Conc., S3 = Ø.5% Conc.

PRE-DIP TREATMENTS OF FUNGICIDES ON THE SOFT-ROT DEVELOPMENT



- PERCENT INHIBITION OVER CONTROL

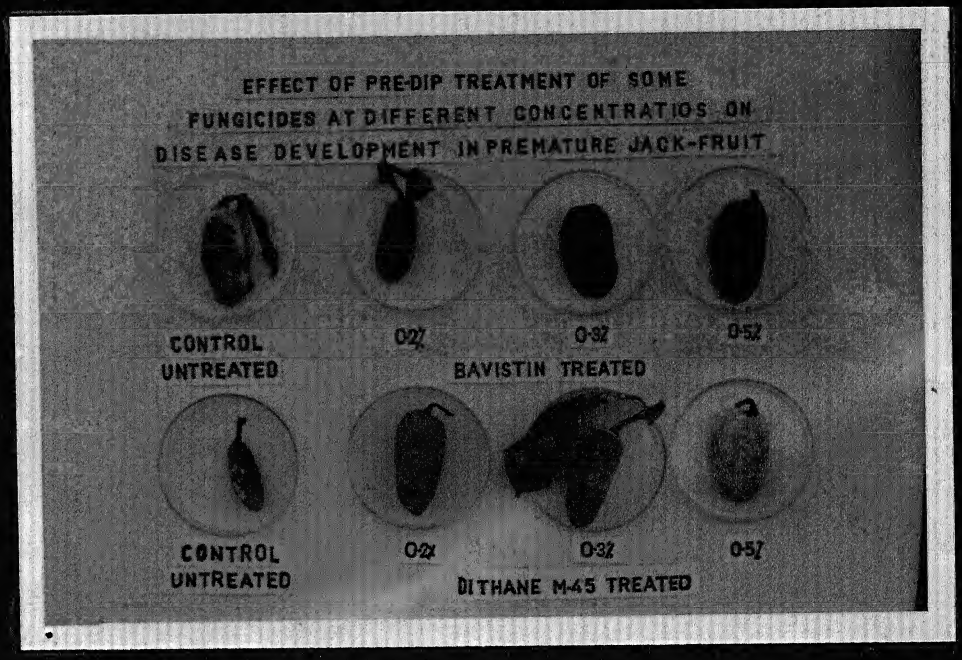
Fig. No. 10(a)

Plate No. 18 (a) :- Effect of pre-dip treatment of fungicides (Bavistin & Dithane M - 45) on the development of soft-rot in premature Jack-fruit inoculated with Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind., In Vivo.

Ø.2% = S1 Conc., Ø.3% = S2 Conc., Ø.5 = S3 Conc.

Plate No. 18 (b) :- Effect of pre-dip treatment of fungicides (Thiram & Captan) on the development of soft-rot in premature Jack-fruit inoculated with Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind., In Vivo

Ø.2% = S1 Conc., Ø.3% = S2 Conc., Ø.5 = S3 Conc.


EFFECT OF PRE-DIP TREATMENT OF SOME
FUNGICIDES AT DIFFERENT CONCENTRATIOS ON
DISEASE DEVELOPMENT IN PREMATURE JACK-FRUIT
CONTROL
UNTREATED
0·2%
0·3%
0·5%
BAVISTIN TREATED
CONTROL
UNTREATED
0·2%
0·3%
0·5%
DITHANE M-45 TREATED

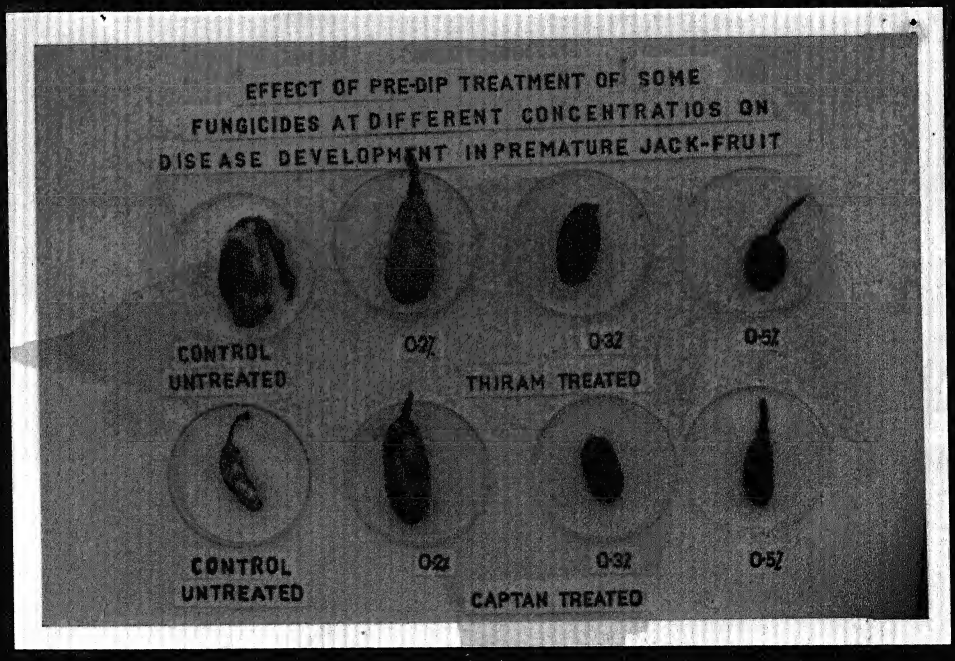

EFFECT OF PRE-DIP TREATMENT OF SOME
FUNGICIDES AT DIFFERENT CONCENTRATIOS ON
DISEASE DEVELOPMENT IN PREMATURE JACK-FRUIT
CONTROL
UNTREATED
0·2%
0·3%
0·5%
THIRAM TREATED
CONTROL
UNTREATED
0·2%
0·3%
0·5%
CAPTAN TREATED

Plate No. 18 (c) :- Effect of pre-dip treatment of fungicides (Benlate) on the development of soft-rot in premature Jack-fruit inoculated with Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind., In Vivo

Ø.2% = S1 Conc., Ø.3% = S2 Conc., Ø.5% = S3 Conc.

EFFECT OF PRE-DIP TREATMENT OF SOME FUNGICIDES AT DIFFERENT CONCENTRATIOS ON DISEASE DEVELOPMENT IN PREMATURE JACK-FRUIT

CONTROL UNTREATED

0·2Z

0·3Z

0·5Z

BENLATE TREATED

TABLE 12 (B) : EFFECT OF POST-DIP TREATMENTS OF FUNGICIDES ON THE DEVELOPMENT OF SOFT-ROT IN PREMATURE JACK-FRUITS (IN VIVO)

S.No.	FUNGICIDES (Active ingredients)	Concentration (%)	Percent soft-rot (Hours) 24	48	72	Percent inhibition over control
1.	Bavistin 2-(Methoxy carbamolyl-benzalmidazole)	S1	3.Ø	8.71	12.63	82.55
		S2	Ø.Ø	Ø.Ø	Ø.Ø	100.Ø
		S3	Ø.Ø	Ø.Ø	Ø.Ø	100.Ø
2.	Dithame M-45 (Zinc ions & manganous ethylene bis (dithoi-ocarbamate)	S1	11.66	23.Ø	40.82	43.47
		S2	5.8Ø	14.98	35.Ø3	51.53
		S3	2.8Ø	7.Ø5	17.69	75.5Ø
3.	Thiram (Tetramethyl thiuram disulphide)	S1	1.6Ø	2.66	5.Ø4	93.Ø2
		S2	1.Ø	2.82	4.35	93.97
		S3	Ø.Ø	Ø.Ø	Ø.Ø	100.Ø
4.	Captan N-Trichloromethyl thio-4-cyclohexene-1 2-dithiocarboximide	S1	6.6Ø	15.61	CFR	Ø.Ø
		S2	5.55	19.71	45.77	36.61
		S3	4.88	19.Ø8	43.84	39.28

Contd.

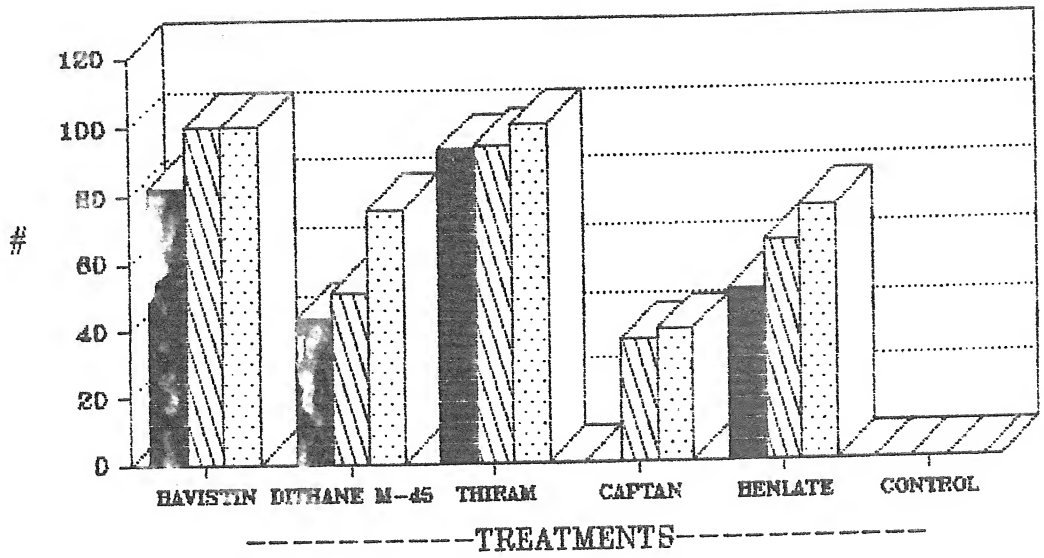
5.	Benlate Methyl-1(buta carbo-moyl)-2 benzo midazole	S1	7.Ø	16.56	35.22	51.22	
		S2	3.Ø	9.8Ø	25.21	65.Ø8	
		S3	2.56	8.88	17.69	75.5Ø	
6.	Control	-	18.Ø5	39.98	CFR		
	CD. at 5% level	-	2.26	5.97	2.43		
	CD. at 1% level	-	3.18	8.38	3.41		

Note :- Each reading is an average of three replicates
inoculated fruits were incubated at 30° C temperature and 100% R.H.
Percent rot was calculated as described by Gaur and Chenulu (1982)
Conc. - S1 = Ø.Ø2% ; S2 = Ø.3% ; S3 = Ø.5%
CFR = Complete Fruit Rotten.

Fig. No. 1Ø (b) :- Effect of post-dip treatments of fungicides on the development of soft-rot in premature Jack-fruits (Artocarpus heterophyllus Lamk.) inoculated with Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. (In Vivo)

S1 = Ø.2% Conc., S2 = Ø.3% Conc., S3 = Ø.5% Conc.

POST-DIP TREATMENTS OF FUNGICIDES ON THE SOFT-ROT DEVELOPMENT



- PERCENT INHIBITION OVER CONTROL

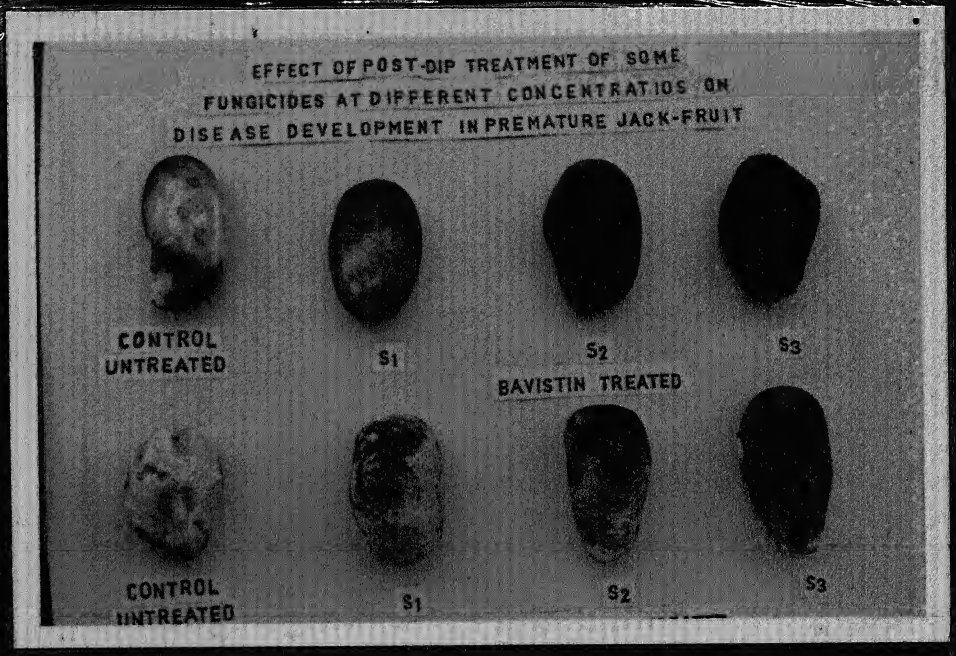
Fig. No. 10(a)

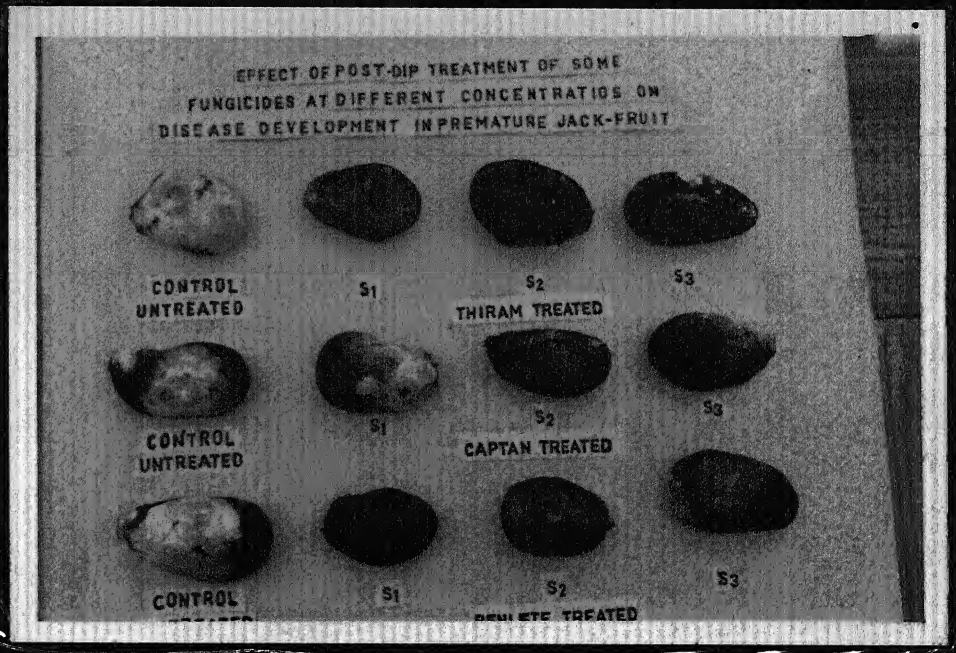
Plate No. 19 (a) :- Effect of post-dip treatment of fungicides (Bavistin & Dithane M - 45) on the development of soft-rot in premature Jack-fruit inoculated with Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind., In Vivo.

S1 = Ø.2% Conc., S2 = Ø.3% Conc., S3 = Ø.5% Conc.

Plate No. 19 (b) :- Effect of post-dip treatment of fungicides (Thiram, Captan & Benlate) on the development of soft-rot in premature Jack-fruit inoculated with Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind., In Vivo

S1 = Ø.2% Conc., S2 = Ø.3% Conc., S3 = Ø.5% Conc.


EFFECT OF POST-DIP TREATMENT OF SOME
FUNGICIDES AT DIFFERENT CONCENTRATIOS ON
DISEASE DEVELOPMENT IN PREMATURE JACK-FRUIT
CONTROL
UNTREATED
S1
S2
S3
BAVISTIN TREATED
CONTROL
UNTREATED
S1
S2
S3


EFFECT OF POST-DIP TREATMENT OF SOME
FUNGICIDES AT DIFFERENT CONCENTRATIOS ON
DISEASE DEVELOPMENT IN PREMATURE JACK-FRUIT
CONTROL
UNTREATED
S1
S2
S3
THIRAM TREATED
CONTROL
UNTREATED
S1
S2
S3
CAPTAN TREATED
CONTROL
S1
S2
S3

The data showed that the percent inhibition over control was 98.37%, 89.66% 95.09%, 49.77% & 96.75% in S1 concentration; It was 100.0%, 100.0%, 97.48%, 61.76% & 100.0% in S2 concentration; It was 100.0%, 100.0%, 100.0%, 69.06% & 100.0% in S3 concentration after 72 hours of incubation period, respectively by all the tested fungicides mentioned above when they were used as pre-dip treatments. The percent inhibition over control was; It was 82.55%, 43.47%, 93.02%, 0.0% & 51.22% in S1 concentration; It was 100.0%, 51.53%, 93.97%, 36.61% & 65.08% in S2 concentration; It was 100.0%, 75.50%, 100.0%, 39.28% & 75.50% in S3 concentration by all the tested fungicides mentioned above when they were used as post-dip treatment after 72 hours of incubation period, respectively.

10 (B). EFFICACY OF PRE AND POST-DIP TREATMENTS OF SOME PHENOLIC COMPOUNDS ON THE DEVELOPMENT OF SOFT-ROT IN PREMATURE JACK-FRUITS (IN VIVO) :

The data presented in the Table No. 13 (A-B); Fig No. (12a-12b); Plate No. (20a-20b) and (21a-21b) to test the efficacy of four phenolic compounds viz., Catechol, Napthol, Pyrogallol and Resorcinol at 250 ppm., (S1), 500 ppm. (S2) and 1000 ppm. (S3) concentration on premature falling in jack-fruits due to soft-rot caused by Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind., revealed that the all

TABLE 13 (A) : EFFECT OF PRE-DIP TREATMENTS OF SOME PHENOLIC COMPOUNDS ON THE DEVELOPMENT OF SOFT-ROT IN PREMATURE JACK-FRUITS (IN VIVO) :

S. No.	PHENOLIC COMPOUNDS	Concentration (%)	Percent soft-rot (Hours) 24	48	72	Percent inhibition over control
1.	Catechol [C6 H4 (OH)2]	S1	4.86	12.81	20.0	67.59
		S2	0.95	2.0	6.67	89.19
		S3	0.0	0.0	0.0	100.0
2.	Napthol (C6 H7 O11)	S1	1.87	3.25	31.0	49.77
		S2	1.05	2.67	7.46	87.91
		S3	0.0	0.0	0.0	100.0
3.	Pyrogallol (C6 H6 O3)	S1	1.89	4.11	10.50	82.98
		S2	0.0	1.0	7.54	87.78
		S3	0.20	0.96	5.0	91.89

Contd.

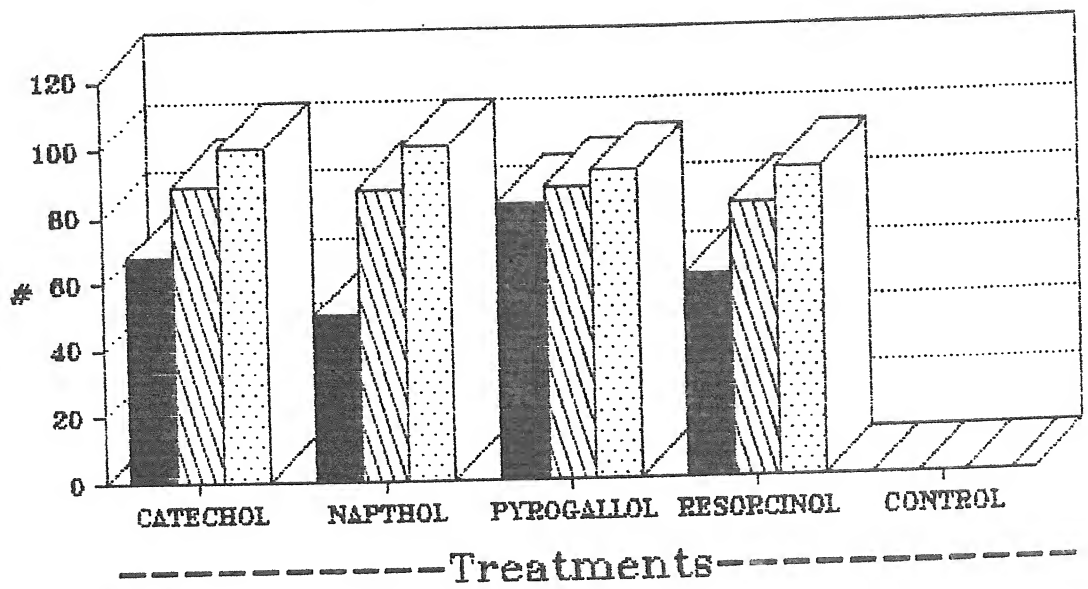
4.	Resorcinol (C6 H6 O2)	S1	3.12	10.46	24.0	61.11
		S2	1.80	4.42	11.20	81.85
		S3	0.50	1.48	4.98	91.93
5.	Control	-	13.70	24.11	CFR	-
	CD. at 5% level		2.31	12.01	8.60	-
	CD. at 1% level		3.24	16.86	12.08	-

Note :- Each reading is an average of three replicates
Inoculated fruits were incubated at 30 C temperature and 100% R.H.
Percent rot was calculated as described by Gaur and Chenulu (1982).
Conc. - S1 = 250 ppm. ; S2 = 500 ppm. ; S3 = 1000 ppm.
CFR = Complete Fruit Rotten.

Fig. No. 11 (a) :- Effect of pre-dip treatments of phenolic compounds on the development of soft-rot in premature Jack-fruits (Artocarpus heterophyllus Lamk.) inoculated with Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. (In Vivo).

S1 = 250 ppm. Conc., S2 = 500 ppm. Conc., S3 = 1000 ppm. Conc.

PRE-DIP TREATMENTS OF PHENOLIC COMPOUNDS
ON THE SOFT-ROT DEVELOPMENT



= Percent inhibition over control

Fig. No. 11 (a)

Plate No. 20 (a) :- Effect of pre-dip treatments of phenolic suspensions (Catechol & Napthol) on the development of soft-rot in premature Jack-fruit inoculated with Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind., In Vivo.

250 ppm. = S1 Conc., 500 ppm. = S2 Conc., 1000 ppm. = S3 Conc.

Plate No. 20 (b) :- Effect of pre-dip treatments of phenolic suspensions (Resourcinol & Pyrogallol) on the development of soft-rot in premature Jack-fruit inoculated with Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind., In Vivo.

250 ppm. = S1 Conc., 500 ppm. = S2 Conc., 1000 ppm. = S3 Conc.

EFFECT OF PRE-DIP TREATMENT OF SOME
PHENOLIC SUSPENSIONS AT DIFFERENT CONCENTRATIOS ON
DISEASE DEVELOPMENT IN PREMATURE JACK-FRUIT

CONTROL UNTREATED | 250 ppm | 500 ppm | 1000m

CATECHOL TREATED

CONTROL UNTREATED | 250 ppm | 500 ppm | 1000 ppm

NAPTHOL TREATED

EFFECT OF PRE-DIP TREATMENT OF SOME
PHENOLIC SUSPENSIONS AT DIFFERENT CONCENTRATIOS ON
DISEASE DEVELOPMENT IN PREMATURE JACK-FRUIT

CONTROL UNTREATED | 250 ppm | 500 ppm | 1000m

RESORCINOL TREATED

CONTROL UNTREATED | 250 ppm | 500 ppm | 1000 ppm

PYROGALLOL TREATED

TABLE 13 (B) : EFFECT OF POST-DIP TREATMENTS OF SOME PHENOLIC COMPOUNDS ON THE DEVELOPMENT OF SOFT-ROT IN PREMATURE JACK-FRUITS (IN VIVO).

S.No.	PHENOLIC COMPOUNDS	Concentration	Percent soft-rot (Hours)			Percent inhibition over control
			24	48	72	
1.	Catechol [C6 H4 (OH)2]	S1	3.39	9.25	22.Ø	69.53
		S2	Ø.82	1.22	5.5Ø	92.38
		S3	Ø.Ø	Ø.25	Ø.9Ø	98.75
2.	Napthol (C6 H7 O11)	S1	12.84	34.Ø	55.99	22.46
		S2	3.Ø	9.99	49.49	31.46
		S3	4.9Ø	15.55	27.89	61.37
3.	Pyrogallol (C6 H6 O3)	S1	7.99	19.8Ø	52.Ø	27.98
		S2	3.99	12.82	29.ØØ	59.83
		S3	Ø.5Ø	1.98	7.Ø5	9Ø.23

Contd.

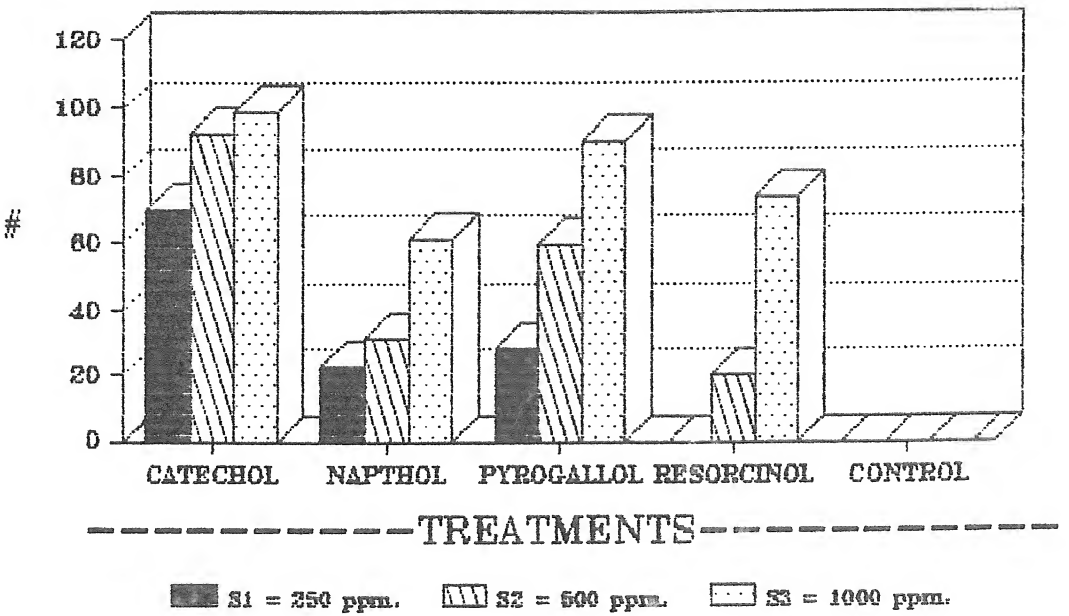
4.	Resorcinol (C6 H6 O2)	S1	16.66	36.Ø	CFR	Ø.ØØ	
		S2	8.69	2Ø.Ø	57.42	2Ø.48	
		S3	2.71	7.36	18.85	73.89	
5.	Control	-	18.Ø5	39.98	CFR	-	
	CD. at 5% level		4.15	6.63	8.15	-	
	CD. at 1% level		5.82	9.31	11.44	-	

Note :- Each reading is an average of three replicates
Inoculated fruits were incubated at 3Ø C temperature and 1ØØ% R.H.
Percent rot was calculated as described by Gaur and Chenulu (1982).
Conc. - S1 = 25Ø ppm.; S2 = 5ØØ ppm.; S3 = 1ØØØ ppm.
CFR = Complete Fruit Rotten.

Fig. No. 11 (b) :- Effect of post-dip treatments of phenolic compounds on the development of soft-rot in premature Jack-fruits (Artocarpus heterophyllus Lamk.) inoculated with Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. (In Vivo).

S1 = 250 ppm. Conc., S2 = 500 ppm. Conc., S3 = 1000 ppm. Conc.

POST-DIP TREATMENTS OF PHENOLIC COMPOUND
ON THE SOFT-ROT DEVELOPMENT



- PERCENT INHIBITION OVER CONTROL

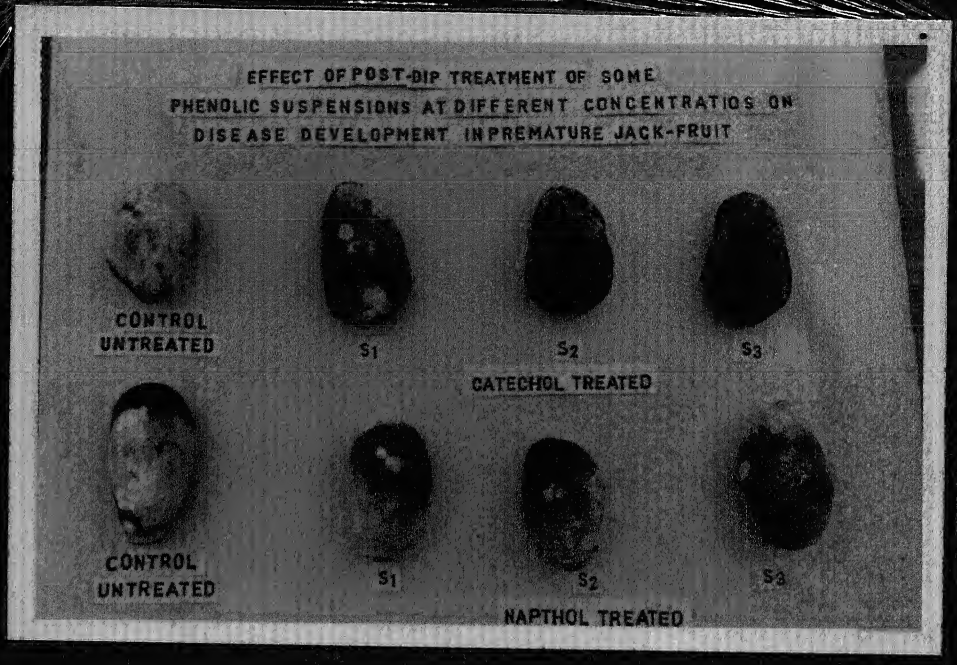
Fig. No. 11 (b)

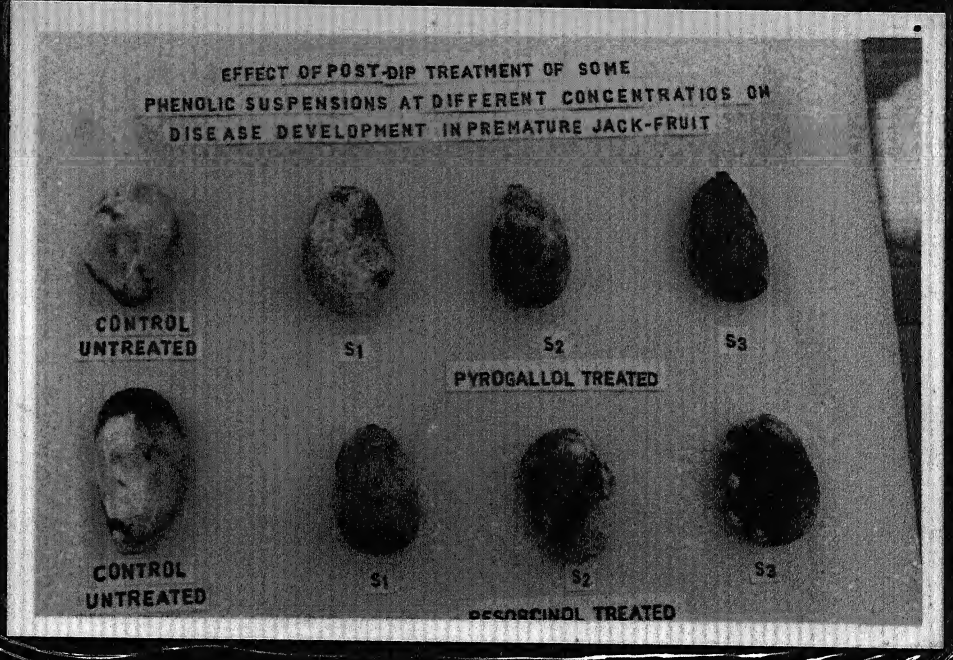
Plate No. 21 (a) :- Effect of post-dip treatments of phenolic suspensions (Catechol & Napthol) on the development of soft-rot in premature Jack-fruit inoculated with Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind., In Vivo.

S1 = 250 ppm. Conc., S2 = 500 ppm. Conc., S3 = 1000 ppm. Conc.

Plate No. 21 (b) :- Effect of post-dip treatments of phenolic suspensions (Pyrogallol & Resorcinol) on the development of soft-rot in premature Jack-fruit inoculated with Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind., In Vivo

S1 = 250 ppm. Conc., S2 = 500 ppm. Conc., S3 = 1000 ppm. Conc.


EFFECT OF POST-DIP TREATMENT OF SOME
PHENOLIC SUSPENSIONS AT DIFFERENT CONCENTRATIOS ON
DISEASE DEVELOPMENT IN PREMATURE JACK-FRUIT
CONTROL
UNTREATED
S1
S2
S3
CATECHOL TREATED
CONTROL
UNTREATED
S1
S2
S3
NAPTHOL TREATED


EFFECT OF POST-DIP TREATMENT OF SOME
PHENOLIC SUSPENSIONS AT DIFFERENT CONCENTRATIOS ON
DISEASE DEVELOPMENT IN PREMATURE JACK-FRUIT
CONTROL
UNTREATED
S1
S2
S3
PYROGALLOL TREATED
CONTROL
UNTREATED
S1
S2
S3

phenolic compounds tested were found effective against disease development. It is clear from the data that pre-dip treatments was most effective than post-dip treatments. The maximum percent inhibition over control was (calculated as stated on page no. 42) observed by catechol followed by pyrogallol in both pre and post-dip treatments while resorcinal and napthol was found to be least effective in pre and post-dip treatment after 72 hours of incubation period, respectively.

The percent efficacy over control was in S1 concentrtion, it was 67.59%, 49.77%, 82.98% & 61.11%; in S2 concentration it was 89.19%, 87.91%, 87.78% & 81.85% and in S3 concentration it was 100.0%, 100.0%, 91.89% & 91.99%, respectively when the phenolic suspensions were used as pre-dip treatments while the percent inhibition over control was in S1 concentration 69.53%, 22.46%, 27.98% & 0.0% in S2 concentration it was 92.38%, 31.46%, 59.83% & 20.48% and in S3 concentration it was 98.75%, 61.37%, 90.23% & 73.89% when the phenolic suspensions were used as post-dip treatment after 72 hour of incubation period, respectively.

10 (C). EFFICACY OF PRE AND POST-DIP TREATMENTS OF WATER SOLUBLE FRACTIONS OF OIL-CAKES ON THE DEVELOPMENT OF SOFT-ROT IN PREMATURE JACK-FRUITS (IN VIVO) :

The data presented in Table No. (14a-14b); Fig. No. (13a-13b); Plate No. (22a-22b). To test the efficacy of water soluble fractions of four oil-cakes i.e. Azadirachta indica A. Juss. (neem-cake), Arachis hypogea Linn. (groundnut-cake), Madhuca indica J.F. Gmel. (mahua-cake) and Ricinus communis Linn. (castor-cake) at 2.5% (S1), 5.Ø% (S2) and 1Ø.Ø% (S3) percent concentraion on premature falling in jack fruits due to soft-rot caused by Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind., revealed that the percent efficacy over control (calculated as stated on page no. 43) was maximum in the Azadirachta indica (neem-cake) followed by Madhuca indica (mahua-cake) in pre and post-dip treatments while minimum efficacy over control was recorded in Ricinus communis (castor-cake) and Arachis hypogea (groundnut-cake) in both the treatments after 72 hours of incubation period, respectively.

The data showed that the percent inhibition over control was 69.79%, Ø.Ø%, 65.31%, & Ø.Ø% in S1 concentration; It was 88.81%, 47.79%, 77.62% & 53.87% in S2 concentration and it was 1ØØ.Ø%, 65.85%, 99.44% & 61.46% in S3 concentration when the oil-cakes was used as pre-dip treatments while the percent inhibition over control was recorded 61.65%, Ø.Ø%, 44.75% & Ø.Ø% in S1 concentration; It was 79.22%, 17.6Ø%, 5Ø.14% & Ø.Ø% in S2 concentration and it

TABLE 14 (A) : EFFECT OF PRE-DIP TREATMENTS OF WATER SOLUBLE FRACTIONS OF OIL- CAKES ON THE DEVELOPMENT OF SOFT-ROT IN PREMATURE JACK-FRUITS (IN VIVO). :

S.No.	OIL-CAKES USED	Concentration (%)	Percent soft-rot (Hours) 24	48	72	Percent inhibition over control
1.	Azadirachta indica A. Juss. (Neem-cake)	S1	3.21	8.68	27.Ø	69.79
		S2	1.86	4.2Ø	1Ø.Ø	88.81
		S3	Ø.Ø	Ø.Ø	Ø.Ø	1ØØ.Ø
2.	Arachis hypogea Linn. (Groundnut- cake)	S1	18.21	47.22	CFR	Ø.ØØ
		S2	15.Ø	36.81	46.66	47.79
		S3	12.Ø	2Ø.Ø	3Ø.52	65.85
3.	Madhuca indica J.F.Gmel (Mahua-cake)	S1	5.12	13.66	31.Ø	65.31
		S2	2.18	8.86	2Ø.Ø	77.62
		S3	Ø.Ø	Ø.Ø7	Ø.5Ø	99.44

Contd.

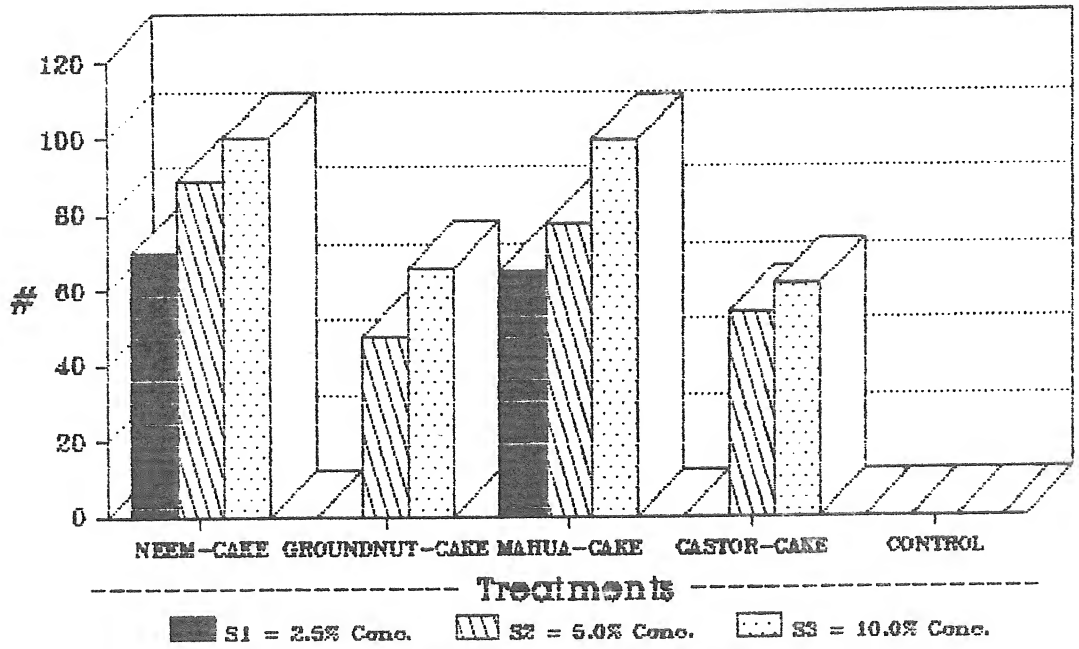
4.	Ricinus communis Linn. (Castor-cake)	S1	20.Ø	46.60	CFR	Ø.ØØ
		S2	18.Ø	35.Ø	41.23	53.87
		S3	12.Ø	15.52	34.44	61.46
5.	Control	-	57.28	89.38	CFR	-
	CD. at 5% level		9.77	8.69	21.8Ø	-
	CD. at 1% level		13.72	12.2Ø	3Ø.6Ø	-

Note :- Each reading is an average of three replicates
Inoculated fruits were incubated at 3Ø °C temperature and 1ØØ% R.H.
Percent rot was calculated as described by Gaur and Chenulu (1982).
Conc. - S1 = 2.5% ; S2 = 5.Ø% ; S3 = 1Ø.Ø%
CFR = Complete Fruit Rotten.

Fig. No. 12 (a) :- Effect of pre-dip treatments of water soluble fractions of some oil-cakes on the development of soft-rot in premature Jack-fruits (Artocarpus heterophyllus Lamk.) inoculated with Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. (In Vivo).

S1 = 2.5% Conc., S2 = 5.Ø% Conc., S3 = 1Ø.Ø% Conc.

PRE-DIP TREATMENTS OF OIL-CAKES ON THE SOFT-ROT DEVELOPMENT



= Percent inhibition over control

Fig. No. 12(a)

Plate No. 22 (a) :- Effect of pre-dip treatments of water soluble fractions of oil-cakes on the development of soft-rot in premature Jack-fruits.

A = Azadirachta indica A. Juss (neem-cake)

B = Madhuca indica J.F. Gmel. (mahua-cake)

2.5% = S1 Conc., 5.0% = S2 Conc., 10.0% = S3 Conc.

EFFECT OF PRE-DIP TREATMENTS OF WATER-SOLUBLE OIL-CAKES ON DISEASE DEVELOPMENT IN PREMATURE JACK-FRUITS IN DIFFERENT CONCENTRATIONS

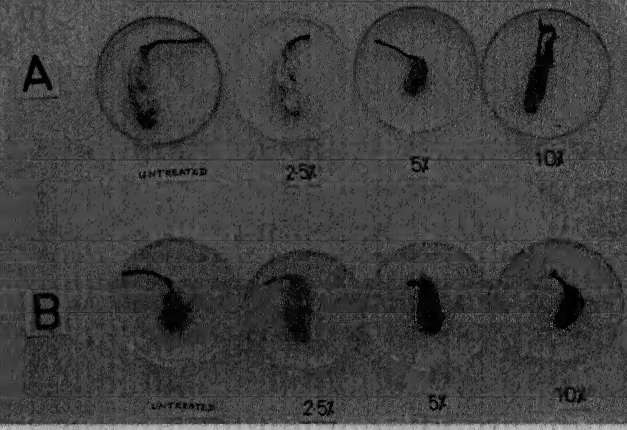


TABLE 14 (B) : EFFECT OF POST-DIP TREATMENT OF WATER SOLUBLE FRACTIONS OF OIL-CAKES ON THE DEVELOPMENT OF SOFT-ROT IN PREMATURE JACK-FRUITS (IN VITRO) :

S. No.	OIL-CAKES USED	Concentration (%)	Percent soft-rot (Hours)			Percent inhibition over control	
			24	48	72		
1.	Azadirachta indica A. Juss. (Neem-cake)	S1	3.7Ø	11.11	27.69	61.65	
		S2	1.33	4.59	15.Ø	79.22	
		S3	1.19	4.39	12.89	82.14	
2.	Arachis hypogea Linn. (Groundnut-cake)	S1	9.89	23.Ø	CFR	Ø.Ø	
		S2	5.Ø9	18.21	84.41	17.6Ø	
		S3	6.Ø	15.8Ø	39.89	24.75	
3.	Madhuca indica J.F.Gmel (Mahua-cake)	S1	7.8Ø	17.Ø	39.89	44.75	
		S2	5.38	14.92	36.Ø	5Ø.14	
		S3	2.36	9.52	23.Ø	68.14	

Contd.

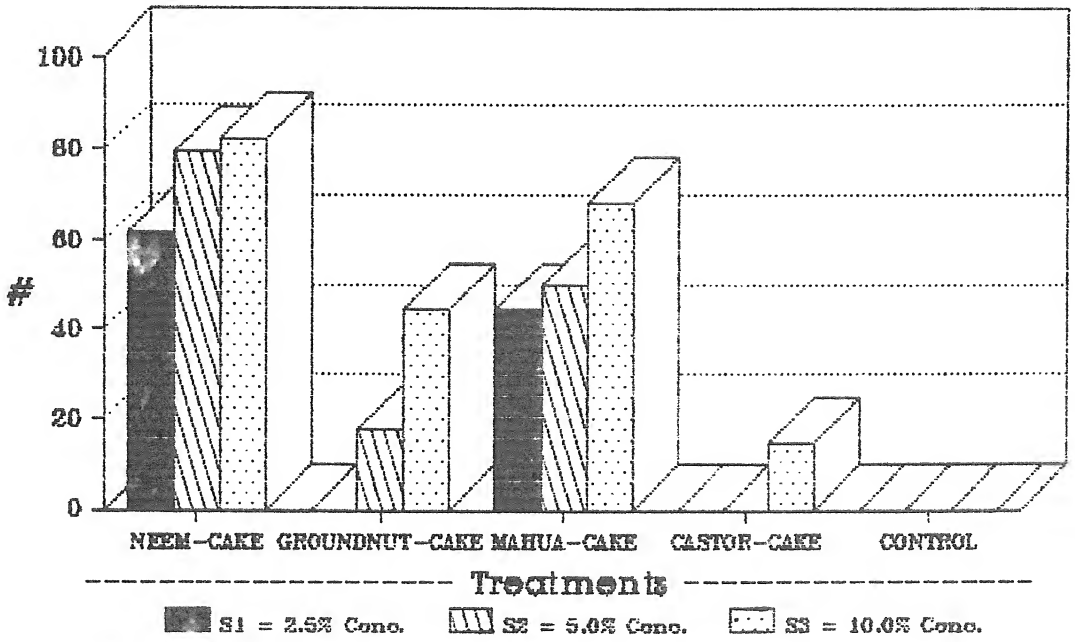
4.	Ricinus communis Linn. (Castor-cake)	S1	7.83	21.56	CFR	Ø.ØØ	[illegible]	[illegible]
		S2	5.Ø9	14.Ø	CFR	Ø.ØØ	[illegible]	[illegible]
		S3	11.89	27.78	61[illegible].5Ø	14[illegible].83	[illegible]	[illegible]
5.	Control	-	18.Ø5	39.98	CFR	-	[illegible]	[illegible]
	CD. at 5% level		4.76	8.11	16.92	[illegible]	[illegible]	[illegible]
	CD. at 1% level		6.68	11.38	23.73	[illegible]	[illegible]	[illegible]

Note :- Each reading is an average of three replicates
Inoculated fruits were incubated at 3Ø C temperature and 1ØØ% R.H.
Percent rot was calculated as described by Gaur and Chenulu (1982).
Conc. - S1=2.5% ; S2=5.Ø% ; S3 = 1Ø.Ø%
CFR = Complete Fruit Rotten.

Fig. No. 12 (b) :- Effect of post-dip treatments of water soluble fractions of some oil-cakes on the development of soft-rot in premature Jack-fruits (Artocarpus heterophyllus Lamk.) inoculated with Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. (In Vivo).

S1 = 2.5% Conc., S2 = 5.Ø% Conc., S3 = 1Ø.Ø% Conc.

POST-DIP TREATMENTS OF OIL-CAKES ON SOFT-ROT DEVELOPMENT



= Percent inhibition over control

Fig. No. 12 (b)

Plate No. 22 (b) :- Effect of post-dip treatments of water soluble fractions of oil-cakes on the development soft-rot in premature Jack-fruits.

A = Azadirachta indica A. Juss. (neem-cake)

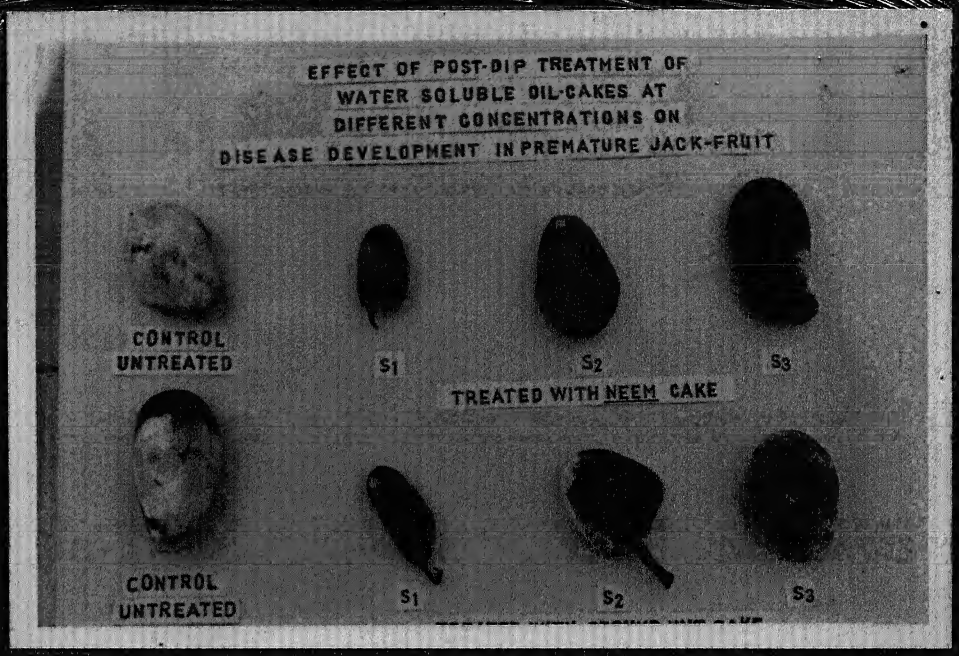
B = Arachis hypogea Linn. (groundnut-cake)

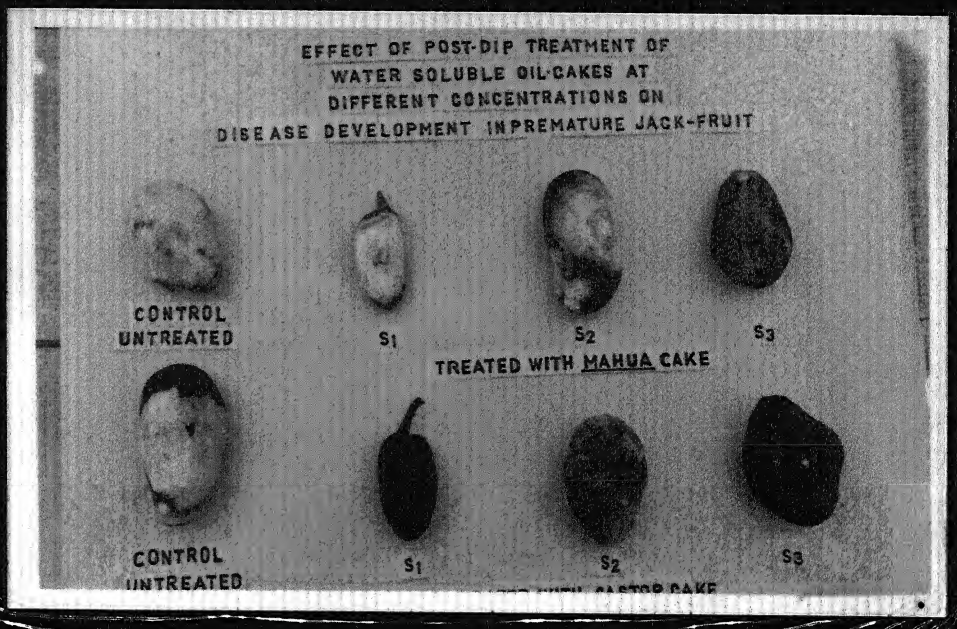
S1 = 2.5% Conc., S2 = 5.0% Conc., S3 = 10.0% Conc.

Plate No. 22 (c) :- Effect of post-dip treatments of water soluble fractions of oil-cakes on the development soft-rot in premature Jack-fruits.

A = Madhuca indica J.F. Gmel. (mahua-cake)

B = Ricinus communis Linn. (castor-cake)


EFFECT OF POST-DIP TREATMENT OF
WATER SOLUBLE OIL-CAKES AT
DIFFERENT CONCENTRATIONS ON
DISEASE DEVELOPMENT IN PREMATURE JACK-FRUIT
CONTROL
UNTREATED
S1
S2
S3
TREATED WITH NEEM CAKE
CONTROL
UNTREATED
S1
S2
S3


EFFECT OF POST-DIP TREATMENT OF
WATER SOLUBLE OIL-CAKES AT
DIFFERENT CONCENTRATIONS ON
DISEASE DEVELOPMENT IN PREMATURE JACK-FRUIT
CONTROL
UNTREATED
S1
S2
S3
TREATED WITH MAHUA CAKE
CONTROL
UNTREATED
S1
S2
S3

was 82.14%, 24.75%, 68.14% & 14.83% in S3 concentration when all the oil-cakes used as post-dip treatment after 72 hours of incubation period, respectively. It is clear from the results that pre-dip treatments was most efficacy than the post-dip treatments.

DISCUSSION

AND

CONCLUSION

Rhizopus rot of jack-fruits (Artocarpus heterophyllus Lamk.) is a well known disease and was first reported by Chaudhary (1949). The susceptibility of jack-fruits to infection by Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind. was demonstrated by falling of buds, flowers and premature fruits showing rot. Immature jack-fruits were susceptible throughout 90-day's of experimental period preceding harvest. Susceptibility of jack-fruits to infection decreased as harvest approached. The reason for this findings is not clear, but could be attributed to a response of the fungus to the jack-fruits ripening process, or rot may be attributed as a response of the fungus to the physical changes occuring on the surface of the jack-fruits. The infection of immature jack-fruits observed during the present investigation indicate that Rhizopus rot of jack-fruits are possible over a large period of the year starting from January to April. The wide host range may well be the reason for out-break of Rhizopus rot of jack-fruits in new areas of cultivation including area of the present studies, Jhansi and Tikamgarh districts of Bundelkhand region. This may also be attributed to the reluctance of the cultivaters for using of chemicals and biological agents for the control because of the their toxicological effects.

Temperature and relative humidity are

important environmental factors which significantly influence the infection of immature jack-fruits by Rhizopus stolonifer (Ehrenb. ex. Fr.) Lind.. In the present investigation relating to environmental studies the maximum disease incidence/growth and sporulation increased with the increasing temperature upto 30 °C, and hundred percent relative humidity. While no significant disease incidence /growth and sporulation were found at 40-45 °C temperature (Table No. 4-5) which was in agreement with Thakur (1972); Kanwar et. al. (1973).

During the present investigation regarding the optimum period required for infection of immature jack-fruits in laboratory conditions, highest level of infection occured when incubation period of 48 hours was imposed on host. The period of 48 hours of incubation may have been necessary for obtaining sufficient pathogen-epidermal surface contact of jack-fruit in present experiment and also because the inoculum was mixed in the form of agar-disc and was applied in cavity method, it was not done throughout the fruit surface. Cavity method and agar disc inoculation was found to be highly effective in causing severe rotting. Similar types of results have been observed by Rao (1977), Chopra (1982), Mehta (1983).

The premature falling of fruits is also possibly occurring because of the enzymes of the test pathogen produced on the infected peduncles resulting in their premature fall. The production of these enzymes by the test pathogen could also be attributed to the very active synthesis of DNA, RNA and specific protein in the infected tissue and the correlation of these macromolecules with the synthesis of the enzymes on the surface of such tissues. The very active synthesis of the DNA, RNA and protein was earlier reported by Akazawa and Uritani (1955).

The greater incidence of premature falling of jack-fruits could also be attributed to an increase in the amount of the inoculum and also on increase in the germination of mycelium or the germination of spores in field conditions getting the required period of temperature and wetness. However, the measure of quantity of inoculum denisity was not very clear. The initial infection on jack-fruits may well be attributed to the presence of large number of non-motile wind disseminated spores, produced in round black sporangia of Rhizopus stolonifer. The spores comming in the contact with the epidermal tissues of young jack-fruits and begin to germinate immediately and completely in 48 hours of incubation period. The spore germinates by the emergence of germtube. The germtubes subsequently elongate forming well

branched mycelium which appears in the form of hyphae to the surface of jack-fruits and forming a white fluffy mass resulting particularly in the loss of peduncle which is rotten causing in the fall of young fruits.

Susceptibility of 26 fruits and vegetables to Rhizopus stolonifer rot demonstrated significant difference in the degree of virulence. It was highest in case of Carica papaya Linn., Solanum melongena Linn., Lycopersicon esculentum mill., Momordiac charantia Linn., Citrullus vulgaris var., fistulosus Duth. & full., Trichosanthes dioica Roxb., Coccinia indica wt. Arn., Cucumis sativus Linn.. While it was least in Pyrus malus Linn., Citrus sinensis (L.) Osbeck., Pyrus communis Linn., Emblica officinalis Gaertn., (sour varieties). This is in confirmity with findings of Sinha & Prasad (1986), Siddiqui and Vishwakarma (1994). The difference in the degree of virulence may well be attributed to a negative correlation between the amount of acidity of the test fruits and vegetables with R. stolonifer . The high degree of virulence in some test fruits and vegetables may be attributed to the amount of sweetness (the amount of sugars) present in them. The decrease in virulence of some fruits & vegetables as in Pyrus malus, Citrus sinensis , Pyrus communis, Citrus lemon, Emblica officinalis, Carissa carandus (sour varities) may be attributed to the amount of acidity in

them indicating a simple negative correlation existing between acidity and the test pathogen. The findings are in confirmity with those of Carter (1934).

During the present studies on the growth and sporulation of the pathogen. Potato dextrose agar medium and malt extracts agar medium followed by sabouraud's dextrose agar medium (semi-solid and liquid media) were found to be significantly effective for the growth and sporulation of the test pathogen, R. stolonifer (Table No. 2-3). Similar types of results were reported by Siradhana (1978), Sinha & Prasad (1986) and Shukla (1993).

During the present investigation to find out the effective control measures, a number of fungicides and chemicals viz., phenolic compounds, amino-acids and biological agents were tested to determine their effectiveness against the pathogen, R. stolonifer.

During present studies on the efficacy of five fungicides on the soft-rot development (in premature jack-fruits) against test pathogen, R. stolonifer (in vivo). Bavistin, Benlate and Dithane M-45 were found to be highly effective against soft-rot development. Capton was found to be least effective whereas, thiram was moderately effective

in both pre and post dip treatments (Table No. 12a-12b). This is in confirmity with those of Thakur & Chenulu (1974), Pandey et. al. (1979), Singh & Singh (1989).

In the present study Catechol and Resorcinol was found to be highly effective while Pyrogallol was found to be least effective whereas Napthol was found to have moderate effect on the soft-rot development against test pathogen in both pre and post dip treatments (Table No. 13a-13b). Findings are in confirmity with those of Vidyasekharan (1974), Singh & Singh (1981) and Atri et. al. (1985), Chile (1993).

The significant control of rotting in jack-fruits treated with phenolic compounds and fungicides (both in pre and post dip treatments) may well be attributed to the inhibitory influence of the above on the content of pectic enzymes which in such treated tissues were very significantly reduced or totally inhibited.

The untreated and inoculated fruits showed high amount of rotting which may well be because of the production of pectic enzyme and polymethylgalacturonase at high concentration, Kaul & Sharma (1992).

Influence of soil-amendment with amino-acids

on pathogenic behaviour of R. stolonifer showed significant differences. Amendment of soil with arginine, threonine and leucine showed maximum percentage of growth inhibition while the growth inhibition was significantly lower with the amendment of soil-with glutamic acid and proline whereas methionine and tyrosine showed moderate effect (Table No. 11). The inhibition caused by amendment of soil with above amino-acids may be attributed to the non-production of certain enzymes. The exact nature of enzymes is yet to be ascertained which are vital for the growth and infection of the test pathogen. Results are in confirmitly with those of Prakash and Prasad (1993).

The work carried out on fungitoxic properties of plant extracts against the mycelial growth of R. stolonifer revealed that Allium sativum Linn., Zingiber officinale Rosc., Ocimum sanctum Linn., Azadirachta indica A. Juss. and Clerodendron phlolytis Linn. have strong antifungal activity causing very active inhibition of the test pathogen (Table No. 8). The inhibition may be attributed to the presence of fungicidal properties of toxic compounds in case of Allium sativum. The role of Allicin have been earlier reported by skinner (1955). Amonkar and Benerji (1971) have also reported antifungal growth inhibition with Allium sativum caused by its active principle (diallyl-disulphide

and diallyl-trisulphide). The active principle- 3, 7-dimethyl-2, 6 Octydieneal (citral) isolated from ginger (Zingiber officinale) by Singh et. al. (1983) has been found fungitoxic against spore germination of a number of fungi. Similarly the inhibition caused by the extracts of plant tested may be attributed to the presence of phenolic substances and non volatile compounds of unknown nature which are yet to be throughly investigated. In present investigation leaf extracts of Ocimum sanctum Linn. (tulsi) was significant in causing inhibition against test pathogen which is in agreement with Patil (1992).

The present work on water soluble fractions and soil amendment with oil cakes tested against the growth of pathogen in in vitro & in vivo indicate the significant inhibition effects with Azadirachta indica A. Juss. (neem-cake) followed by Madhuca indica J.F. Gmel. (mahua-cake). While Arachis hypogea Linn. (groundnut-cake) was least effective, whereas Ricinus communis Linn. (castor-cake) showed moderate effect (Table No. 9-10 & 14a-14b) in both in vitro & in vivo which may be attributed to the production of phenolic compounds which are known for their fungicidal properties. Findings are in confirmity with those of Singh and Singh (1970), Chakrabarti & Sen (1991) and Kikani & Vaishnow (1992).

During the present investigation on the growth inhibition of test pathogen, R. stolonifer with cultural filtrates of some fungal organisms revealed their antangonistic effect which may be the result of their matabolic by- products, some of which are inhibitory to the pathogen. The ability of cultural toxicity of the biological agents against the growth of the pathogen may be attributed to the release of fungicidal compounds, which is evident in case of culture filtrates of Aspergillus niger followed by Cladosporium sp., Nigrospora sp., Chaetomium sp. and Stylopage sp.. However, Fusarium sp., Altermaria sp., Curvularia sp., Helminthosporium tetramera and Aspergillus flavus revealed that they were comparatively insignificant in causing inhibition (Table No. 7a-7b). Which may be attributed to the competition for nutrients or may be that they produce volatile antimicrobial substances under in vivo condition. These results are in agreement with the findings of Dannis & Webster (1971). The active inhibition with cultural filtrates of A. niger and some other fungi stated earlier may well be the effect of fungitoxic metabolites or may be attributed to the inactivation of enzymes necessary for the growth of the test pathogen. Observations are in confirmity with those of Lang (1975), Skidmore & Dickson (1976), Rai et. al. (1977), Roy (1991) and Doshi & Singh (1991).

Work is still in progress to isolate and fully investigate such metabolites, which are causing inactivation of enzymes-vital for the growth of the pathogen.

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* = Not seen in original.